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SOUTHEASTERN MICHIGAN WASTEWATER MANAGEMENT SURVEY SCOPE STUDY.--ETC(U)
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SOUTHEASTERN MICHIGAN
WASTEWATER MANAGEMENT
SURVEY SCOPE STUDY

REPORT COMPOSITION

SUMMARY REPORT
OVERVIEW OF STUDY

- **BACKGROUND APPENDIX** — BASE DATA INFORMATION
- **PLAN FORMULATION APPENDIX** — THE PROCESS OF PLANNING
- **COMMENTS APPENDIX** — PUBLIC REVIEW OF DRAFT REPORTS

Under PLAN FORMULATION APPENDIX:

- **INSTITUTIONAL ARRANGEMENTS APPENDIX** — EXISTING AND PROPOSED WASTEWATER MANAGEMENT ORGANIZATIONS
- **DESIGN AND COST APPENDIX** — TECHNICAL DESIGN AND ESTIMATED COSTS OF WASTEWATER MANAGEMENT COLLECTION AND TREATMENT SYSTEMS
- **EVALUATION APPENDIX** — IMPLICATIONS AND USE POTENTIAL OF PROPOSED WASTEWATER MANAGEMENT SYSTEMS
- **PUBLIC PARTICIPATION APPENDIX** — PROGRAM FOR PUBLIC INVOLVEMENT AND PARTICIPATION IN PLANNING PROCESS

Under DESIGN AND COST APPENDIX:

- LAND IRRIGATION AND COLLECTION FACILITIES (DOW ENGINEERING INC.)
- LAGOON TREATMENT AND CONVEYANCE SYSTEMS (BAUER ENGINEERING, INC.)
- ALTERNATIVES FOR STORMWATER RUNOFF CONTROL (AYRES, LEWIS, NORRIS AND MAY, INC.)
- ADVANCED WASTEWATER TREATMENT FACILITIES (STANLEY CONSULTANTS)
- INDEPENDENT PHYSICAL-CHEMICAL TREATMENT FACILITIES (IN CONSULTATION WITH WALTER J. WEBER Jr. Ph.D.)
- GEOLOGIC CONSIDERATIONS (ANDREW J. MOZOLA, Ph.D.)
- LAND TREATMENT OF WASTEWATER IN SOUTHEASTERN MICHIGAN (DEPT. OF CROP & SOIL SCIENCES, MSU)
- WASTEWATER IRRIGATION USING PRIVATELY OWNED FARMLAND IN SOUTHEASTERN MICHIGAN (DOW ENGINEERING, INC.)

Under EVALUATION APPENDIX:

- ECOLOGICAL ASSESSMENT FOR WASTEWATER MANAGEMENT SEM (INSTITUTE OF WATER RESEARCH, MSU)
- HYGIENIC ASSESSMENTS (SCHOOL OF PUBLIC HEALTH, U OF M)
- ECONOMIC (AREA) ASSESSMENT AND SOCIAL ASSESSMENT (MR. PAUL M. REID)
- AGRICULTURAL ECONOMIC ASSESSMENT AND AN ANALYSIS OF ZONES PROPOSED FOR LAND TREATMENT OF WASTEWATER (MR. LEE A. CHRISTENSEN, ECONOMIC RESEARCH SERVICE, USDA.)
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Chapter 1

INTRODUCTION

THE STUDY

The aim of the Southeastern Michigan Wastewater Management Survey Scope Study is to develop long-range wastewater management plans for Southeastern Michigan. These plans would complement the water quality plans of the State of Michigan and thus assist in meeting the planning requirements of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). To reach this aim the needs and objectives related to water pollution problems in Southeastern Michigan were defined, alternative plans were formulated, treatment systems were designed, and the impacts of these alternative plans were assessed and evaluated based on technical, economical, institutional, aesthetic, ecological, and social considerations.

This study augments the wastewater treatment planning effort developed in the State of Michigan's plan entitled *Plans for Water Quality Management, Phase II, for Southeastern Michigan* by:

1. examining various advanced wastewater treatment technologies,

2. providing additional alternatives for control of critical combined storm and sanitary sewer overflows and other forms of urban stormwater runoff,

3. presenting alternative wastewater management systems which would approach the 1985 "no discharge of pollutants" goal in Public Law 92-500,

4. phasing the implementation of the alternative plans in accordance with Public Law 92-500, and

5. presenting alternative plans that would protect the surface waters of Southeastern Michigan, including Lake Erie, for swimming and other recreational uses, and for the protection and propagation of fish, shellfish and wildlife.

The planning objectives pertaining to wastewater management in Southeastern Michigan have been developed from goals and objectives of Federal, state, regional, and local agencies and the specific study authorities as described more fully in the later portions of this report. These six basic Southeastern Michigan Wastewater Management study objectives are:

1. To provide a range of potentially implementable regional wastewater management plans for Southeastern Michigan.

2. To develop these plans in harmony with the existing facilities and short range plans of the governmental agencies within the region.

3. To include in the objective development of these plans, alternative technical systems for the control of pollution from municipal, industrial, and urban stormwater runoff sources.

4. To develop these technical systems to approach with the best available technology the 1985 "no discharge of pollutants" goal of the Federal Water Pollution Control Act Amendments of 1972.

5. To provide an alternative regional wastewater management plan to achieve a lesser effluent quality standard as defined by the State of Michigan.

6. To identify, evaluate, and display the impacts of these regional wastewater management plans in terms of economics, social, cultural, aesthetic, institutional, and environmental considerations.

THE STUDY PROCESS

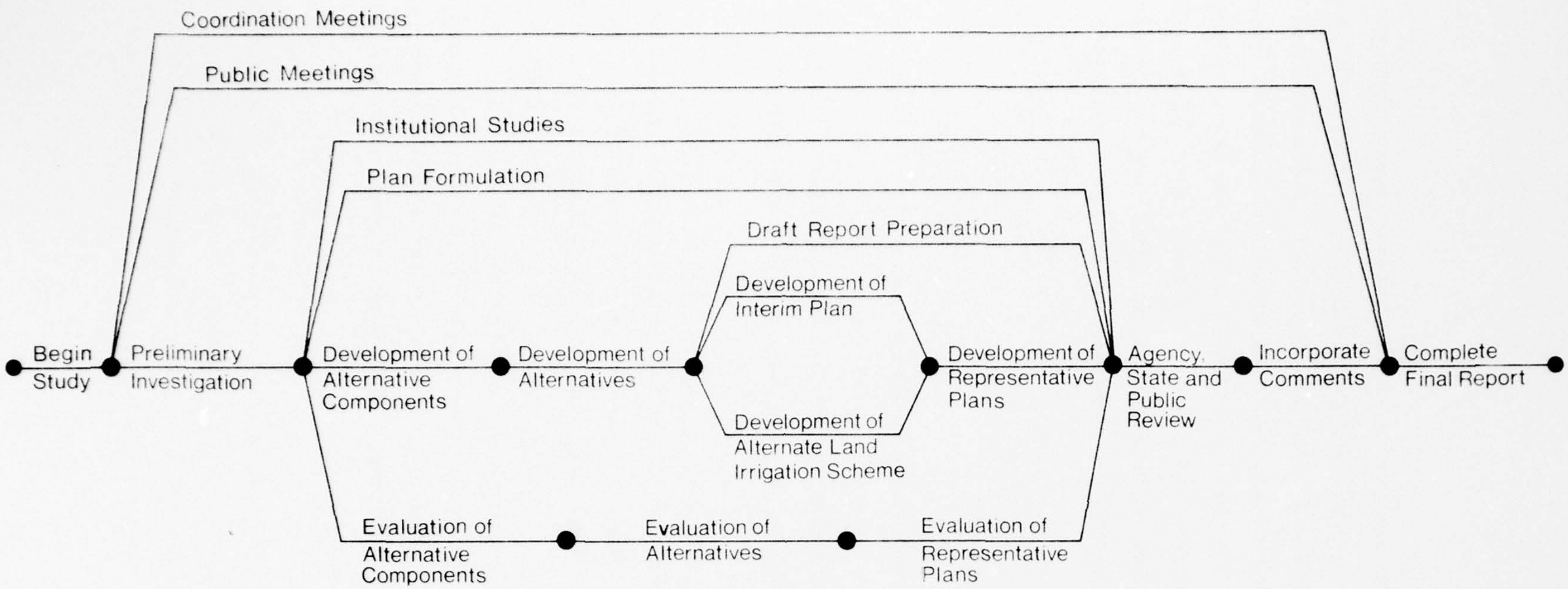
The plan formulation process is the systematic development of alternative plans to meet the various objectives of the study. It is an iterative process which interacts with the measurement and evaluation of impacts related to study objectives. Initial plans are developed based on technological choices. The impacts of these plans are displayed and the evaluation of these impacts lead to modifications in the plans. The final iteration should produce those alternatives that have the fewest adverse and the most beneficial impacts possible within the constraints and criteria.

Plan Formulation Methodology

The Detroit District Wastewater Management Study was conducted in three stages as shown in the network diagram in Figure 1. As can be seen from this diagram, the study was a highly integrated composition of engineering design, plan formulation, evaluation, public participation, and coordination processes.

The first stage consisted of initial investigations and the development of technical information which led to the formation of a range of wastewater management alternative components. A multitude of wastewater control systems and processes within six areas of wastewater management were reviewed and designed. From this, technical systems and facilities for various portions of the study area were developed which, when combined, could result in the highest level of treatment at the minimum financial cost. These became the technical components used to form total wastewater management alternatives in stage two.

Stage two resulted in the formation and evaluation of eleven alternatives which cover the entire range of wastewater management considerations and impacts, including: wastewater treatment, collection and conveyance, stormwater control, sludge handling and disposal, cost estimates, and



SOUTHEASTERN MICHIGAN WASTEWATER MANAGEMENT STUDY
GENERAL STUDY NETWORK
Figure 1

estimates of land, chemical and energy requirements. In addition, a plan was derived from the State of Michigan's current water quality plan to provide a comparison and to show the tradeoffs involved in selecting between alternatives designed to meet different water quality standards. The impacts of these alternatives were evaluated as to their ecological, hygienic, economic, agricultural economic, social and aesthetic considerations.

Stage three resulted in the formation of Representative Plans. The evaluation of the second stage alternatives pointed out changes which could be made to improve the overall acceptance of the most favorable of these alternatives. When these changes were made, the Representative Plans were the result. The impacts of these three wastewater management plans were evaluated in the same manner as the eleven second stage alternatives.

IMPACT ASSESSMENTS AND EVALUATIONS

Impact Identification and Measurement

Impact assessments consist of the identification and measurement of changes that would occur as a result of the implementation of a particular plan. These assessments can be either qualitative or quantitative. For example, a quantitative measurement can be arrived at and the impacts assessed when it is desired to find the number of pounds of chemicals needed in the operation of a given wastewater treatment plant of a given size. On the other hand, the number of fish in a stream if the dissolved oxygen goes from 5 milligrams per liter to 6 milligrams per liter could not be determined numerically.

Evaluation of Impacts

Evaluation is basically a decision-making tool which allows for the consideration of factors not considered in engineering design. A very elementary definition of evaluation would be the process of assigning the

value of beneficial or detrimental to the impacts that result from a particular plan. These beneficial or detrimental values are weighed in terms of several broad categories: ecological, economics, social, hygienic, aesthetic and agricultural economics. An evaluation carried out in this manner would include not only a judgment of the ability of a system to achieve its primary goals but also a judgment of the effect that the system would have on the surrounding area and how that system would contribute to local, regional and national objectives. Consideration of such factors as these impacts would be useful in anticipating problems which could arise due to implementation of a plan. Early diagnosis of problem areas would thus allow design changes prior to implementation of a plan. The evaluation would finally be used to narrow the range of plans and ultimately to select the plan which, in the judgment of the decision makers, contributes the most to local, regional and national objectives.

Participation and Coordination

Throughout the conduct of the study, members of various governmental agencies and public interest groups were involved and participated in the study through a study coordinating committee. The committee included representatives of the following agencies and groups:

Environmental Protection Agency - Region V
Soil Conservation Service, U. S. Dept. of Agriculture
Bureau of Sport Fisheries and Wildlife, Dept. of Interior
Michigan Water Resources Commission
Institute of Water Research, Michigan State University
Southeast Michigan Council of Governments
Metropolitan League of Women Voters
Detroit Metropolitan Water Department

The objectives of the committee were: (1) to provide prospective alternative plans, (2) to serve as a forum for varying technical and

public views to insure full cooperation and (3) to provide insight and review on alternative proposals as spokesmen for their respective organizations.

The State of Michigan concurrently conducted a regional study for much of the same Southeastern Michigan area based on a lower level of wastewater treatment. This study provided most of the information used to develop the Interim Alternative presented later in this report. The State and the Corps coordinated fully, in this respect, eliminating duplication of effort while providing information pertinent to the development of each study.

The Institute of Water Research, Michigan State University, was the prime ecological evaluator. Its staff provided guidance throughout the development of technical systems with regard to favorable and unfavorable impacts of alternative technical choices. They also evaluated the various plans and provided total impacts on the region.

The Soil Conservation Service provided large amounts of soil data required in the evaluation and selection of lands suitable for land irrigation. They have also served as liaison between the Corps and the people in these respective areas with whom they deal in their normal activities to encourage them to take a more objective look at land irrigation of treated wastewater.

The Southeast Michigan Council of Governments was involved in the development of population projections and projected expansion of service areas. It provided information regarding current plans for the study area in the field of water supply and wastewater facilities for help in defining existing and proposed facilities.

The general public and other interest groups were involved through a series of public meetings, informal workshops, and seminars or presentations conducted during the course of the study. A public information brochure, "The Search for Clean Water," presenting the developments of the first phase

of study, was distributed. These tools were used to inform interested people about study progress, to solicit their reaction to any and all proposed alternatives, and to gather pertinent information. The reactions and information obtained were used to help form the initial alternatives and to help in the later screening process. The impact of the coordination and public involvement programs is discussed in more detail later in this report.

Institutional Arrangements

For the purpose of this study, institutions are defined as organizations, authorities, and relationships by which wastewater management systems and controls are implemented. The purpose of an investigation of institutional management schemes is to analyze the capabilities of existing and proposed wastewater management organizations relative to selected technical wastewater management systems. A number of institutional management schemes, each possessing sufficient authority to plan, construct, operate and maintain the systems developed during the study, have been proposed for the Southeastern Michigan area. These institutions can be classified in six categories which cover management on various levels of political interaction. These six classifications involve wastewater management by:

- State Agency or Utility
- Regional Agency
- County Agency
- Municipal or Local Agency
- Water and Sewage Authority
- Management thru Intergovernmental service agreements (referred to as intercounty agreements)

1. STATE AGENCY OR UTILITY - This type of institutional mechanism involves an executive or departmental agency to the State actually undertaking the direct performance of an urban function. In practice, aspects

of functions may be transferred to a State agency rather than the total function. For example, if a State agency provides water for a metropolitan region, this agency is usually responsible for the actual source of the water supply plus the major trunk lines to convey the water from the source throughout the metropolitan region. Local distribution systems, however, are often left to the localities themselves.

2. REGIONAL AGENCY - The multiple purpose District/Authority represents an independent unit of government established through State law to perform a number of services in all, or most portions, of a metropolitan area. The multiple purpose District/Authority may be established initially with only 1 or 2 actual functions; however, the enabling legislation vests, in the area affected, the capability for the District/Authority to take on additional functions as the need arises.

3. COUNTY AGENCY - Under this type of an arrangement, the county government increases its provision of services which are normally of a municipal nature to include the entire county. This action requires the transfer of functions from muncipalities and any special districts together with the gradual expansion of activities in unincorporated urban areas. It may be necessary for the State to grant a number of functional powers to counties in metropolitan areas. Act 342, Public Acts of 1939 allows a county to provide wastewater management services within its boundary as well as in consenting neighboring governmental units. (Unless otherwise identified, Public Acts refer to current wastewater management legislation in the State of Michigan).

Certain legislative acts stipulate that the county agency is capable of providing services within a boundary specifically limited to a local area. Act 40, Public Acts of 1956, Chapter 20, stipulates that a designated "Agency," in this case a drain commission, may provide for collection and transmission of wastewater within a county. Act 185, Public Acts of 1957, established a Department of Public Works to provide for WWM services within a county.

4. MUNICIPAL OR LOCAL AUTHORITY - The limited purpose metropolitan special district or authority is an independent unit of government organized to perform one or more urban functions throughout all or a part of a metropolitan area. In most cases, the activity is service, as opposed to regulatory; for example, water supply or sewage disposal. The financing of such an independent unit of government is primarily through service changes, sales, rents and tolls. Revenue bonds constitute the primary source of capital funds for project construction.

5. WATER AND SEWAGE AUTHORITY - Act 233, Public Acts of 1955 allows for the establishment, by consenting governmental units, of an authority to provide both wastewater and water supply services. The authority can finance facility construction by the provision of contract bonding and, in this aspect, the provisions are similar to those mentioned in Act 342, Public Acts of 1939. Full faith and credit for these bonds is established by the financial stability of the contracting governmental units.

6. MANAGEMENT THRU INTERGOVERNMENTAL SERVICE AGREEMENTS - Under such a device, one unit of government conducts an activity jointly or cooperatively with one or more other units of government. Typically, contracts may be drawn up whereby one public corporation or unit of government agrees to provide specified services to other units of government according to terms specified in the contracts. The extraterritorial power, therefore, represents the exercise of authority by one unit of government beyond its traditional political boundary. For example, the Detroit Metropolitan Water Department and the Wayne County Road Commission provide sewage service to communities under Intergovernmental Service Agreements.

The examination of these six institutional management schemes took place in two evaluations. The first was to determine the potential of five existing representative wastewater institutions created by current legislation to implement proposed regional wastewater management plans. The second evaluation examined a range of institutional management schemes which involved the combination of existing and proposed management systems.

Chapter 2

SUMMARY OF BACKGROUND

THE SOUTHEASTERN MICHIGAN REGION

The study area of this report, as shown in figure 2, includes all or part of eight Southeastern Michigan counties. They are: all of St. Clair, Macomb, Wayne and Washtenaw Counties; approximately 75 percent of Oakland, Lenawee, and Monroe Counties, and approximately 30 percent of Livingston County. This area is a mixture of highly urbanized, suburban and outlying agricultural areas with a total population of approximately four-and-one-half million people and a total area of 4,900 square miles.

The climate in Southeastern Michigan is moderated by the stablizing influence of the Great Lakes prevailing westerly winds passing over Lake Michigan which subdue extremes in weather conditions. The mean annual temperature compiled at Detroit is approximately 49 degress Fahrenheit. The mean monthly temperature ranges from a high of approximately 73 degrees in July to a low of 25 degrees in January.

In general, the annual precipitation does not vary greatly over Southeast Michigan. The average annual precipitation over the study area varies from 28 inches at Mt. Clemens to about 34 inches at Adrian. The precipitation is usually ample for the growth and development of vegetation, averaging 31 inches annually over the area with less than 25 percent of the total as runoff. Total annual snowfall averages vary from 42 inches at Port Huron to 29 inches at Monroe. Long term records for this area show that precipitation is evenly distributed throughout the year, varying from about 2 inches in January to slightly over 3 inches in June.

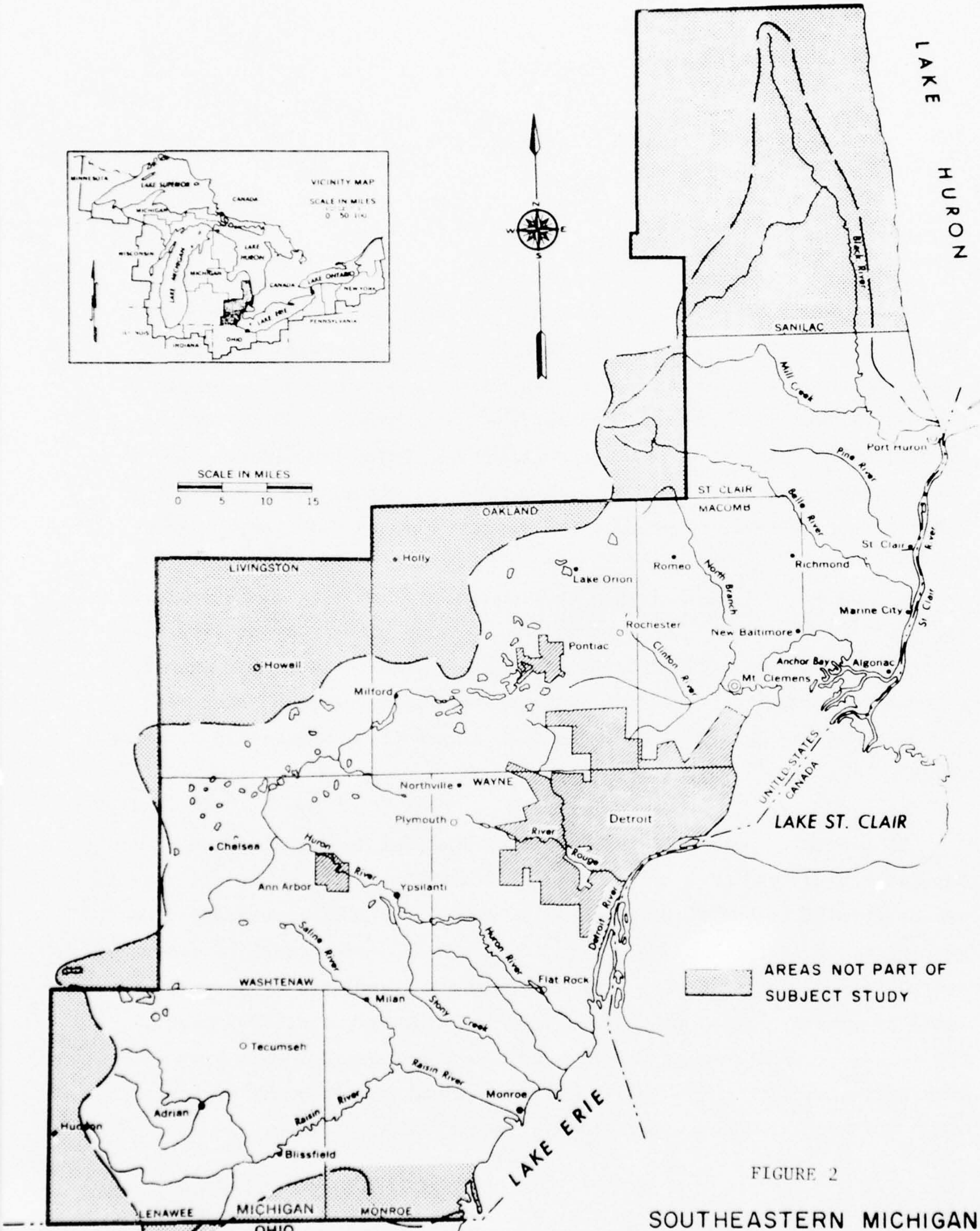


FIGURE 2

SOUTHEASTERN MICHIGAN
STUDY AREA

Southeastern Michigan is subject to two types of storms. The first type is the large area storm of long duration and moderate intensity and the other type is the short term, thunderstorm type rainfall of short duration and high intensity. The longer duration storms occur any time throughout the year, but intense local storms of the thunderstorm type usually occur in the late spring and throughout the summer. Local records indicate that major storms which produce high runoff over large areas have been limited to a duration of three days or less.

The topography of the study area can be divided into two distinct land forms. In the western half, or upstream portions of the major tributaries, rolling to rugged terrain is interspersed locally with relatively flat areas. Numerous inland lakes, interconnected by marshy lands, and small streams, are found in the area. In the eastern half or lower lake bed portion of the study area it is predominantly level without any natural form lakes. From the lake shore inland the elevation rises gradually from 600 to 1,000 feet.

WATER RESOURCES

Seven principal streams traverse the Southeast Michigan area. Data on their drainage areas is presented in Table 1. It should be noted that part of the drainage areas of some of these streams falls outside the area covered in the wastewater management survey scope study.

Table 1

RIVER DRAINAGE AREAS

Stream	Drainage Area (Square Miles)
Black River	746
Belle River	199
Pine River	232
Clinton River	767
Rouge River	455
Huron River	923
Raisin River	1,043

Numerous natural and artificial lakes can be counted as one of Southeast Michigan's major natural assets. Most of the natural lakes are located in the moraine hills and outwash region in the northwestern portion of the area. There are a total of 3,681 lakes, with a total lake acreage of 51,005 acres, and 954.4 miles of inland lake shoreline. In addition, the waters and shoreline of the Great Lakes and connecting channels provide additional resources to the Southeast Michigan area with approximately 300 miles of shoreline.

DEMOGRAPHIC CHARACTERISTICS

Southeastern Michigan, like the nation, has experienced expanding urbanization over the past several decades. The three central counties -- Macomb, Oakland, and Wayne -- have served as the hub of this outward growth. Sub-centers of population growth encircle the city of Detroit at varying distances. These include the cities of Monroe on the south; Ann Arbor and Ypsilanti on the west; Southfield, Royal Oak, Troy and Pontiac to the north; Warren, Sterling Heights, St. Clair Shores and Mt. Clemens to the near northeast, and Port Huron still farther northeast.

The population of Southeastern Michigan increased 1,411,000 from 1950 to 1970, and accounted for 56 percent of Michigan's growth of 2,503,000. Due to a decline in the birth rate after 1960 and to some leveling of economic growth, the population gain of the southeastern area dropped to about 560,000 from 1960 to 1970, compared to 851,000 the previous decade. The population figures are shown in Table 2.

Table 2

POPULATION BY COUNTIES

County	1950 Pop.	1950 % Total	1960 Pop.	1960 % Total	1970 Pop.	1970 % Total
Lenawee	64,629	1.9	77,789	1.8	81,951	1.7
Livingston	26,725	0.8	38,233	0.9	58,967	1.2
Macomb	184,961	5.4	405,804	9.5	625,309	13.0
Monroe	75,666	2.3	101,120	2.4	118,479	2.4
Oakland	396,001	11.6	690,259	16.2	907,871	18.9
St. Clair	91,599	2.7	107,201	2.5	120,175	2.5
Washtenaw	134,606	3.9	172,440	4.1	234,103	4.8
Wayne	2,435,235	71.4	2,666,297	62.6	2,669,604	55.5
Totals	3,409,422		4,259,143		4,816,459	

Due to the decentralized growth of economic enterprises, primarily manufacturing, retail and service activities, the City of Detroit has decreased in population since 1950. The rest of Wayne County, as well as the adjoining counties of Macomb and Oakland, achieved significant population gains during the two decades since 1950. Only Washtenaw of the outlying counties has experienced similar high rates of population increase. The "built-up" capacity of Southeastern Michigan has been estimated to be nearly 20 million people.

ECONOMIC CHARACTERISTICS

The core economic activity of Southeastern Michigan for some decades has been manufacturing, with automotive production as the major component. This industry, which is basic to the manufacturing complex, had its inception in Detroit and has continued to maintain an important portion of its fabricating and assembly operations within the region. Automotive plants are scattered widely over the region. Other industries are located both

along the shoreline and inland. Secondary metal fabricators, food processing, and power plants are concentrated in the northeast (St. Clair and Clinton River basins); primary metal production, chemicals and allied products, and power plants, are located in the central area (Detroit and Rouge River basins); and secondary metal fabricators, paper products and power plants are situated in the southwest (Huron and Raisin River basins).

From 1950 to 1970, total employment increased 471,933--from 1,343,172 to 1,815,105. Although manufacturing employment registered a small numerical increase, this sector of the economy declined from 45.8 percent to 36.8 percent of the total. During this same period, non-manufacturing has experienced a significant upward trend. From 1954 to 1967, while manufacturing employment grew 64,108, employment in retail, wholesale and selected services mounted 131,430.

Urbanization has been spreading from the central city--Detroit--and from the other urban centers to the surrounding communities and townships. One feature of this movement has been the dispersed pattern of economic establishments, such as, manufacturing plants, shopping centers, office and professional service complexes. The largest portion of this spread of economic activity has been confined to the three central counties of Wayne, Oakland and Macomb, the metropolitan statistical area. In 1950, employment in the Detroit Metropolitan area constituted 88.8 percent of the total of the nine counties. By 1970, it still accounted for 82.3 percent.

LAND USE

Southeastern Michigan is significantly influenced by the character and activities of the metropolitan areas which form parts of this important region. The standard metropolitan statistical area of Detroit composes the three central counties of Wayne, Oakland, and Macomb. Washtenaw County, with Ann Arbor as its major city, forms the Ann Arbor metropolitan area. Monroe County, to the south, is included in the Toledo, Ohio, standard metropolitan statistical area.

The map in Figure 3 depicts the 1965 major land uses within the seven major counties of the region. This land use pattern was surveyed and mapped by the Detroit Regional Transportation and Land Use Study. TALUS, a special project of the Southeast Michigan Council of Governments and its predecessor, the Detroit Metropolitan Area Regional Planning Commission. Industrial corridors, highway networks, major residential areas and regional parks are shown for the predominant land uses. Since 1950, the successive incorporation of over 20 cities and villages, from former township lands that were considered farm or rural, has highlighted the process of spreading urbanization.

As might be expected from increased urbanization, the farm and rural populations have experienced marked declines in their numbers. The latest census figures (1970) show that only Monroe County, with some 53 percent, and St. Clair County, with 48 percent rural populations, still have significant rural characteristics. This reduction in farm numbers and population reflects the consolidation of farming units, decreasing farm family size and some change in farm definition. Even though the value of farm products produced in the Southeast Michigan region has continued to rise, the percent of land in agriculture has diminished.

Major crops grown in the area are corn, grain, soybeans, and alfalfa. In addition to cropland, the Southeast Michigan river basins contain approximately 17 percent of their land in forests, estimated at 665,700 acres. Oakland County has the greatest concentration with 28 percent, while Monroe and Wayne Counties have the least with ten percent each. As the need for more recreation land and land for urban expansion increases, forest land for wood products will give way to multiple use for recreation, aesthetics and municipal parks.

EXISTING WATER QUALITY

Water quality investigations were conducted by the Public Health Service, the Institute of Water Research, state and local agencies, and

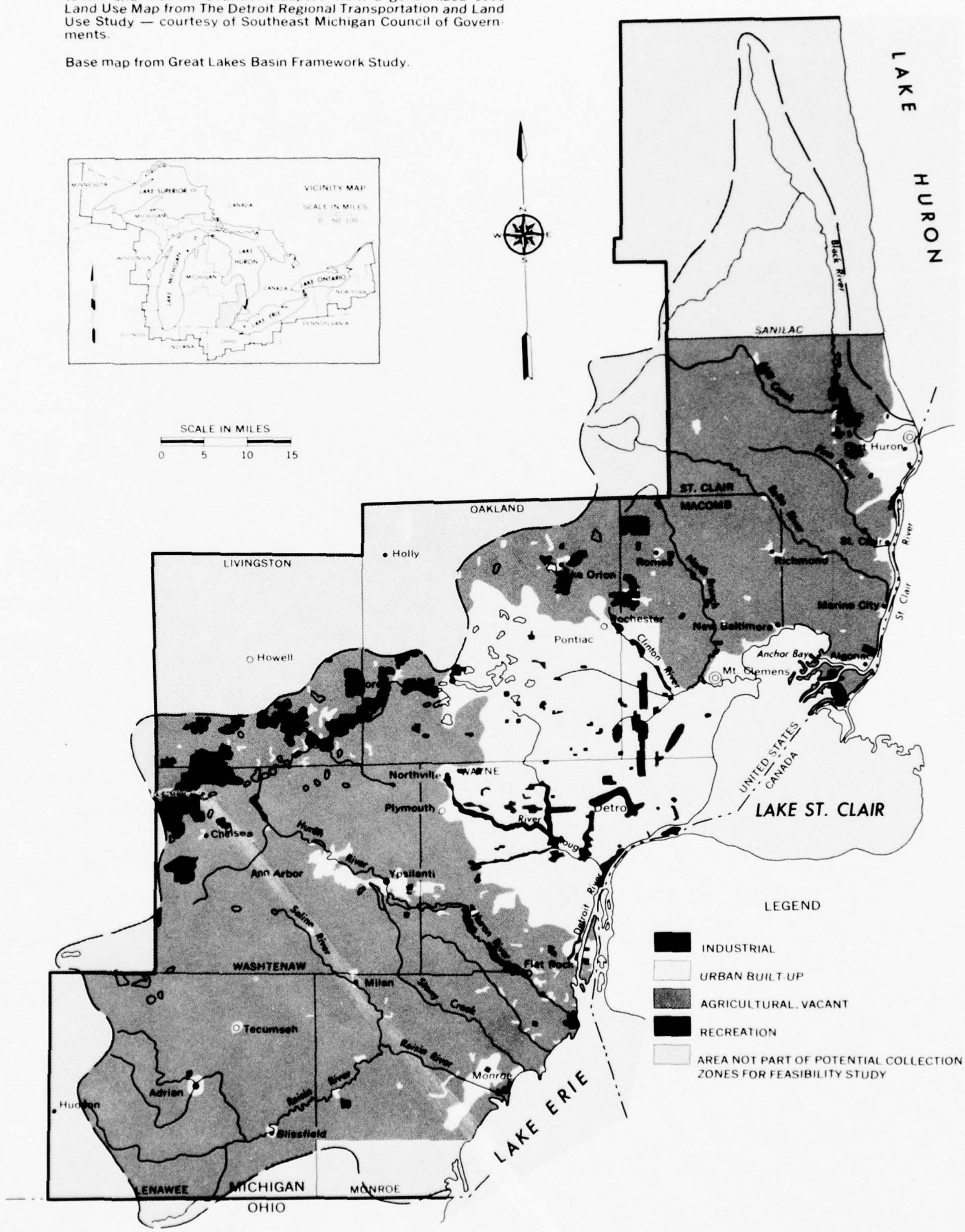
others on the major surface waters of the area. The condition of these waters is reflective of the areas it drains or flows through. There are four main sources of pollution from the urbanized areas: stormwater outlets, combined sewer overflows, industrial outfalls, and sewage plant outfalls. In addition, pollution occurs from direct runoff from agricultural lands and from shore and bank erosion.

The water quality of the St. Clair River is directly related to the quality of the water from Lake Huron and the Black, Pine, and Belle Rivers. The water from Lake Huron is of high quality. The Black, Pine and Belle Rivers are located in the least densely populated portion of the study area. The water quality throughout these basins is generally good except at or near outfalls of combined sewers, industry, and municipal sewage treatment plants. Where these streams discharge into the St. Clair River, the water quality of the river is degraded. Except for localized increases in coliform counts for short, but variable distances below municipalities, the water quality of the St. Clair River is good.

In general, the quality of the water in Lake St. Clair is good, because of the inflow from the St. Clair River. The Clinton River, however, receives discharges from many sewage treatment plants and combined sewer overflows before discharging into Lake St. Clair. The Clinton River basin drains a large portion of the rapidly developing areas north of Detroit. The upstream reaches exhibit generally good water quality with relatively low coliform levels. As the river passes through population centers its quality decreases. Low dissolved oxygen levels and high BOD levels are found, indicating large organic loads. Fairly high levels of nitrate and phosphate, noted near the river mouth, indicate significant nutrient inflows. The river does not have the capacity to assimilate these pollutants and thus there are areas of contamination at its mouth and occasionally at Metropolitan Beach on Lake St. Clair.

Land Use Patterns for St. Clair, Macomb, Oakland, Wayne, Washtenaw and Monroe Counties adapted from a generalized 1965 Land Use Map from *The Detroit Regional Transportation and Land Use Study* — courtesy of Southeast Michigan Council of Governments.

Base map from Great Lakes Basin Framework Study.



Wastewater Management Feasibility Study
Southeast Michigan — Lake Erie
GENERALIZED LAND USE PATTERN — 1965

U.S. Army Corps of Engineers, Detroit District.

The Detroit River from its head to its junction with the Rouge River has satisfactory water quality during normal weather conditions. However, during periods of rainfall in excess of approximately one-half inch, the combined sewer outfalls overflow the collection system along the Detroit River and discharge contaminated stormwater and raw sewage.

The River Rouge Basin includes the River Rouge, Upper River Rouge, Middle River Rouge, Lower River Rouge, and various small tributaries. The waters of the River Rouge basin are very high in both total and fecal coliforms throughout all but the extreme upstream reaches, indicating contamination of a domestic origin. The waters are moderate in suspended solids but relatively high in dissolved solids, which is reflected by high chloride levels, high iron content and increased conductance. Nitrate and phosphate levels indicate that the waters are enriched with nutrients throughout the basin; however, the monitoring station at the mouth of the River Rouge indicates a recent decline in these levels. The dissolved oxygen levels are low at a majority of the stations in the basin, with several stations having levels below 1 mg/l. The accompanying high BOD levels throughout the basin indicate the rivers carry a large organic load. Visible films of oil, prominently present in the past, have been virtually eliminated by new and improved treatment facilities recently installed by industries. The general quality of water throughout the basin is such that all water uses would have some degree of impairment.

Lake Erie has been classified by most water condition experts as an eutrophic lake. It is greatly over-nourished in dissolved nutrients and suffers seasonal oxygen deficiency. Although still below levels directly lethal to fish and food organisms, the concentration of dissolved solids has increased significantly since 1920. The value of the fish catch, however, is declining due to the near disappearance of higher value fish stocks.

Tremendous algae blooms have occurred in the past and the ultimate algae decomposition has caused widespread destruction of bottom organisms quite important to the life of many Lake Erie fishes. Mercury levels are dangerously high, but pesticide levels (DDT and Dieldrin) are moderately low. Over 85 percent of the Michigan waters of Lake Erie contain high concentrations of inorganic nitrogen and soluble phosphates. It is recognized that much of the nutrient problem originates from municipal and industrial wastewaters. Further, bacterial levels near large metropolitan centers of the size of Detroit, have been, and continue to be, a direct health hazard.

The Huron River Basin includes the Huron River, Mill Creek, Letts Creek, Portage River, Silver Creek, and Mann Creek. The waters of the Huron basin contain low total and fecal coliform levels in the upstream reaches above Ann Arbor. High total coliform levels are present in the reach below Ann Arbor with a high fecal coliform level just above Ypsilanti. Fairly high coliform levels are found below other population centers and at the mouth of the river. Suspended solids levels are lower than those in the Raisin basin and compare favorably to the median value of 33 mg/l for the southeastern region. This lower level is possibly due to the effects of the various impoundments which would allow for a natural settling of suspended solids. Total dissolved solids and chlorides appear to present no problem to the various water uses. The nitrate and phosphate levels indicate that the waters are enriched with nutrients, particularly during the spring months, measured at the monitoring station at the mouth of the river. Dissolved oxygen levels are relatively good throughout the basin with some decrease apparent below wastewater treatment plants. The main problem in the basin is the high level of nutrients in surface waters.

The River Raisin Basin includes the River Raisin, Saline River, Wolf Creek, South River Raisin, Bear Creek, and Macon Creek. The waters in the Raisin basin exhibit a fairly low total coliform level in the upstream reaches while the fecal coliform level is high, indicating that the source

of these coliforms is probably of a domestic origin. In the lower reaches, below the population centers, the total coliform level is high. The water throughout the basin is moderately high in total dissolved and suspended solids, while the chloride content is relatively low. The nitrate and phosphate levels throughout the basin would indicate that the streams are enriched with nutrients. This is particularly noticeable during the spring months. The streams, even in the upstream reaches, exhibit the high hardness levels typical of Michigan surface waters. Various stations throughout the basin have recorded low dissolved oxygen and high BOD values, which indicate a heavy organic waste load is carried by the streams. This is particularly noticeable at the monitoring station near the mouth of the river. The main problems in this basin appear to be the high level of nutrients found in the streams as well as the low dissolved oxygen values found at various locations.

There are various small streams such as Jordan Creek, Beaugian Creek, Swan Creek (St. Clair Co.), Salt River, Ecorse Creek, Swan Creek (Monroe Co.), Stony Creek, Sandy Creek, and Otter Creek, for which there is limited water quality data available.

Chapter 3

PLANNING OBJECTIVES AND TECHNICAL CRITERIA

Planning objectives pertaining to wastewater management in Southeastern Michigan have been determined by Federal, state, regional, and local agencies. These provide the basis for plan formulation, impact assessment, and evaluation processes.

OBJECTIVES

Public Law 92-500, Federal Water Pollution Control Act Amendments of 1972

Public Law 92-500 establishes goals, objectives, and programs for improvement of water quality in the United States. The law proclaims two general goals for the Nation:

1. To achieve wherever possible by July 1, 1983, water that is clean enough for swimming and other recreational uses, and clean enough for the protection and propagation of fish, shellfish, and wildlife.

2. And by 1985 to have no discharges of pollutants into the Nation's waters.

The new Amendments also provide several general and specific objectives relating to water quality, comprehensive regional planning, and resource conservation. Those relating to water quality are:

1. the discharge of toxic pollutants in toxic amounts shall be prohibited,

2. that public participation in water quality programs shall be encouraged, and

3. that water quality programs shall emphasize the reduction in duplication of effort.

Those relating to comprehensive regional planning are:

1. that wastewater management planning be carried out on an areawide basis wherever possible,

2. that wastewater management programs be designed to control and treat all sources of wastes including point sources, non-point sources, and in-place or accumulated sources, and

3. that wastewater management plans must be developed for waste treatment needs in the study area for a 20-year period.

Those relating to resources conservation are:

1. to encourage waste treatment management which results in construction of revenue producing facilities providing for the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products and the reclamation of wastewater, and

2. to encourage waste treatment management which results in integrating facilities for sewage treatment and recycling with facilities to treat, dispose of, or utilize other industrial and municipal waste.

3. to encourage waste treatment management in combination with "open space" and recreational considerations.

United States-Canadian Agreement

The general goals of the U. S. Canadian Great Lakes Water Quality agreement are to restore and enhance the water quality of the International Great Lakes and to prevent further pollution as a result of population growth, resources development, or increased water use.

The agreement describes some general water quality objectives that have been characterized as the five freedoms of water quality. These state that the waters of the Great Lakes should be:

1. Free from substances that will settle to form putrescent or otherwise objectionable sludge deposits or that will adversely affect aquatic life or waterfowl;

2. Free from floating debris, oil, scum, or other floating materials in amounts sufficient to be unsightly or deleterious;

3. Free from materials producing color, odor, or other conditions in such a degree as to create a nuisance;

4. Free from substances in concentrations that are toxic to human, animal, or aquatic life; and

5. Free from nutrients in concentrations that create nuisance growths of aquatic weeds and alage.

In addition to these general goals and objectives, the agreement spells out eight specific water quality objectives for the Great Lakes. This list includes specific limits covering microbiology, dissolved oxygen, total dissolved solids, taste and odor, pH iron phosphorous, and radioactivity. It also specifies five interim objectives to be used until more specific limits can be determined. The items covered include temperature,

mercury and other toxic heavy metals, persistent organic contaminants, settleable and suspended materials, oil petrochemicals and immiscible substances. A non-degradation clause is also included which provides for further study on 18 specific constituents or substances.

Finally, the agreement outlines some specific program objectives and guidance. It specifies that programs and measures for Great Lakes water quality improvement shall either be completed, or in the process of implementation, by December 31, 1975. Some of the specific areas that are to be incorporated into water quality programs include control of eutrophication and pollution from municipal sources, industrial sources, agricultural, forestry, and other land use activities, shipping activities, dredging activities and onshore and offshore facilities. In addition, the programs should provide for the development of a joint contingency plan and the identification and control of hazardous polluting substances.

Objectives relating to wastewater have been proposed by state, regional and local agencies. Many of these goals and objectives are similar to the ones noted above and to each other.

State Objectives

The state objectives were aimed at the 1990 development of the area. The primary objective of the planning would be:

1. To protect the surface waters of Southeastern Michigan according to designated uses--for water supply, for recreation values, and for fish, wildlife and other aquatic life.

In the metropolitan area this objective would be met by an expanded wastewater collection system to wastewater treatment plants. These plants would have secondary treatment of activated sludge with phosphorus removal and would then discharge the treated effluent to the St. Clair River, the Detroit River and to the Lake Erie Waterway.

In the outlying local communities, which are outside the regional system, the wastewater treatment plants would have advanced treatment and phosphorus removal or would produce a stable effluent which would then be discharged to the inland streams. The requirements of a stable effluent are shown in Table 3. Also, an alternate economic evaluation of land disposal would be made.

2. To use existing systems as a base for implementing a centralized water supply and sanitary sewer system.

3. To control the critical combined storm and sanitary sewer overflows through retention.

4. To eliminate industrial waste discharge to streams by requiring pretreatment and discharge to a regional interceptor system.

5. To formulate and maintain a land use development pattern that will provide the people of the region with areas that can readily be served by networks of necessary public utilities, such as, water supply, sanitary sewers and treatment plants, and storm drainage.

TABLE 3

STATE OF MICHIGAN

STABLE EFFLUENT REQUIREMENTS

5-day BOD	4.0 mg/l
Ammonia Nitrogen (NH_3-N)	0.5 mg/l
or 20-day BOD	8.0 mg/l (Total)
DO in the Effluent	At least 5.0 mg/l
Total Phosphorus Removal	80 percent minimum
Suspended solids	15.0 mg/l
Fecal Coliform	100/100 ml
Total Coliform	1000/100 ml

Local Objectives

Wayne County. The Wayne County Planning Commission lists two basic goals concerning water resource development. They are (1) to have a rational balance of land uses based on reasonable projections of demand and need, and (2) to conserve human and physical resources. The commission then developed several objectives to fulfill these goals. These objectives are:

1. To obtain some open space and ensure its permanence. It is suggested that ten miles of additional open space be obtained in addition to other organized and active recreation.

2. To allocate the agricultural and open space lands so they are interspaced between areas of concentrated urbanization.

3. To develop public utility services as multi-purpose opportunities.

And lastly, the commission decided certain steps should be taken to reach these objectives. These steps are:

1. To collaborate fully with local governments and regional agencies.

2. To use all available Federal and State funding sources to selectively acquire open space land.

3. To support legislation on environmental protection.

4. To use wisely all existing County land and facilities under a County "property and needs" master plan.

5. To establish both a County Recreation Commission and a County Environmental Quality Commission.

See Table 4 for the Wayne County planning objectives for wastewater management, land use and recreation.

TABLE 4

WAYNE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use	Recreation
To implement a regional water supply and sanitary sewer system, with both plans being approved by the Southeastern Michigan Council of Governments (SEMCOG).	To retain and develop on a regional basis appropriate tracts of non-farm open space for environmental values, aesthetic concerns and economic considerations. These reservations of open space should be obtained by public ownership or easements.	To develop a region-wide recreation program including parks and parkways.
To prevent further combined sewer systems and separate those which can be separated over time.	To recover areas despoiled by the removal of extractable materials and let the land take the form of various types of open space.	To develop an open space area related to recreation and comprising a system of holding ponds for stormwater retention and treatment. Large recreation complexes (possibly covering one or two square miles) should be designed with hills and lakes -- all for year-round use.
To develop new technologies to recover valuable fertilizers and soil conditioners from stormwater, including the recovery of scarce and harmful chemicals.		
To see that sanitary sewer facilities do not serve agricultural and open space due to current development practices.		

TABLE 4 (Cont'd)

WAYNE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use	Recreation
To see that sanitary sewage facilities are capable of adequately protecting the quality of water into which the treated effluent is finally discharged.		
To see that communities developing either separate or combined systems provide sewage treatment facilities which are consistent with the water quality standards of the water resources commission.		
To develop a county master plan for either storm drainage or sewage treatment facilities and have it approved by all units of government involved.		

Lenawee County. The Lenawee County planning objectives for wastewater management and land use are shown in Table 5.

TABLE 5

LENAWEE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
To lower the increasing costs of public facilities such as water supply and sewer service. Public facilities cost more in developments of scattered, large-lot subdivisions; therefore, well-planned concentrated developments should be designed to lower the costs of public facilities.	To protect streams and forests for water supply, flood protection, recreational values and wildlife preserves.
To discourage new undesirable developments by withholding public services.	To maintain large areas of the County as open space since the majority of the County is either underdeveloped or vacant property. Agricultural lands should be preserved as open space where appropriate. These agricultural lands would adopt an exclusive use classification to prevent undesirable urbanization and to retain farming operations.
To use existing systems as a basis for future expansion, and in some cases where it is feasible, to consolidate existing small systems.	

TABLE 5 (Cont'd)

LENAWEE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
A large system is generally more efficient and economical than several small systems.	To implement a comprehensive plan to be initiated and accomplished by all member units. Also a coordinated public improvements policy should be adhered to.
To establish primary service areas around existing systems and population concentrations. Although a County-wide water supply and wastewater treatment system (extending from one centralized service center) is more desirable in terms of efficiency, the next logical consideration is the establishment of primary service areas.	
To implement a County master development plan for water and sewer facilities. All affected member governmental units should implement the plan and revise it whenever appropriate.	

Monroe County. The Monroe County planning objectives for wastewater management, land use and recreation are shown in Table 6.

TABLE 6

MONROE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use	Recreation
To provide for the expanding needs of all Monroe County through a comprehensive utility network of water distribution lines for sewer and storm drainage systems.	To preserve prime agricultural land throughout the County by encouraging planned residential developments and by discouraging scattered subdivisions.	To provide a complete system of neighborhood tot-lots, playgrounds, parks, community playfields, regional parks and preserves. The facilities of Monroe County should be able to provide optimum recreational opportunities through its size, location and available range of facilities.
To satisfy the present and future needs of the people through a complete range of community facilities and services.	To conserve natural physical County resources including, but not limited to air, lakefront, riverfronts and nature preserves.	
To initiate a County program of water pollution control measures to improve water quality in Lake Erie and its tributaries in Monroe County.	To develop and use to the maximum extent existing Port of Monroe facilities.	
	To conserve as unspoiled greenbelts floodplains of the Huron River and drainage ways throughout the County.	

TABLE 6 (Cont'd)

MONROE COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use	Recreation
To provide a centralized sewage collection and disposal system to serve the entire County would not, at this time seem economically feasible by 2000.		

St. Clair County. The St. Clair County planning objectives for wastewater management and land use are shown in Table 7.

TABLE 7

ST. CLAIR COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
To eliminate and control combined sewer overflows. To provide treatment for all municipal wastewater treatment with a minimum of	To meet the land use needs of the County's future urban population in respect to parks, schools, other public and quasi-public facilities, commercial and residential activities.

TABLE 7 (Cont'd)

ST. CLAIR COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
eighty (80) percent removal of phosphorus compounds.	To keep urban development as compact and regular in shape as possible so as to permit the economical extension of urban services.

Washtenaw County. The Washtenaw County planning objectives for wastewater management and land use are shown in Table 8.

TABLE 8

WASHTENAW COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
To discourage industries with heavy water using and waste producing processes from locating near the County rivers. These industries should look instead toward the Great Lakes and their connecting rivers which	To encourage industrial districts where industry is not intermixed with other land uses. To establish efficient community facilities of water supply, sewage disposal and storm drainage, to minimize capital expenditures and

TABLE 8 (Cont'd)

WASHTENAW COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
have large and uniform flow rates.	operating costs, but provide as high a quality of facilities and services as possible.
To be more careful in the policing of illegal sewer connections to storm sewer systems. Along streams there are several points of discharge of land runoff and treated waste effluent. These discharges can cause a localized problem in the stream, irrespective of stream flows.	To preserve open spaces and to conserve natural resources. To protect the better agricultural land (the most productive soils) in the County from being used for other than agricultural purposes.
To improve the efficiency of BOD removal by improved sewage treatment methods.	
To sterlize and eliminate the biological forms that may be present in supplies of sur-	

TABLE 8 (Cont'd)

WASHTENAW COUNTY PLANNING OBJECTIVES

Wastewater Management	Land Use
face runoff of stormwater. Chemical and organic substances, as well as the aquatic life, in natural surface waters often contribute to the taste and odor of the water.	

Macomb and Oakland Counties are in the process of revising their planning objectives and are not included in this report.

These international, national, state, regional, and local objectives together with the specific study authorities formed the basis for developing the six basic Southeastern Michigan Wastewater Management Study objectives. They are:

1. To provide a range of potentially implementable regional wastewater management plans for Southeastern Michigan.

2. To develop these plans in harmony with the existing facilities and short-range plans of the governmental agencies within the region.

3. To include in the objective development of these plans, alternative technical systems for the control of pollution from municipal, industrial, and urban stormwater runoff sources.

4. To develop these technical systems to approach with the best available technology the 1985 "no discharge of pollutants" goal of the Federal Water Pollution Control Act Amendments of 1972.

5. To provide an alternative regional wastewater management plan to achieve a lesser effluent quality standard as defined by the State of Michigan.

6. To evaluate all of these regional wastewater management plans in terms of economics, social, cultural, aesthetic, institutional, and environmental considerations and display these impacts.

TECHNICAL CRITERIA

In order to meet the study objectives it was necessary to define performance criteria for the system design. Effluent quality criteria was the primary factor in the design of a system. Two sets of criteria were established, one to approach the "no discharge of pollutants" goal, and the second as defined by the State of Michigan.

The initial water quality goal of the study was to achieve the highest levels of wastewater treatment using the best available technology. Effluent criteria were established, therefore, to reflect three groups of wastewater constituents to be considered in the design process. These criteria were established based on the limits recommended by the Committee on Water Quality Criteria for water uses such as public water supply, fresh water and marine aquatic habitat and irrigation.

Classification I applies to substances which must be absent or completely removed. This implies reduction to the limit of detectability or to the lowest level attainable by presently available advanced waste treatment technology. Constituents included in Classification I are listed below

with asterisks identifying those items reported in the wastewater profiles utilized for this study.

Pesticides	Lead*
Phenols*	Mercury
Cyanides*	Molybdenum
Antimony	Nickle*
Barium	Selenium
Beryllium	Silver
Boron	Thallium
Cadmium*	Tin
Chromium	Titanium
Cobalt	Zinc*
Copper*	Arsenic

Classification II applies to substances, which along with those in the previous list, comprise the minimum number of constituents to be considered in a system design. These constituents should be reduced to specific concentrations, however, and are identified below if they were present in the wastewater profile data used in this study.

Ammonia	0.5 mg/l
Phosphorous	<50 ug/l in a lake
	<100 ug/l in a river
pH	6.0-8.5
Chloride	250 mg/l
Nitrates and Nitrites-N	10 mg/l
Coliform	10,000/100 ml

Classification III indicates substances which were to be given specific consideration as to their impact in each region. The following were identified as being significant in Southeastern Michigan and should

be reduced to the lowest possible level using accepted processes.

Viruses	Settleable Solids*
BOD_5*	Volatile Solids*
Surfactants	Total Organic Carbon
Fecal Streptococci	Total Oxygen Demand
Taste and Odors	Gamma Radiation
Oil and Grease*	Synthetic Organics
Floatables	COD*
Suspended Solids*	

The constituents and levels contained in the preceding classification were developed as guidance for the initial planning phases of the wastewater management program. It was recognized early in the study, however, that in order to adequately design and determine the cost of wastewater treatment facilities, a list of critical pollutant levels would be required. A review of the information available on the constituents in the three classifications indicated that there was little, if any, data available on many of them in terms of what constitutes the present background level in receiving waters or what would be an acceptable level of concentration for the constituents. This was due to a historical lack of adequate monitoring efforts and the high cost of analyses. Thus, a list of specific effluent quality standards was selected based on an environmental scan of data which was available. These are shown in Table 9. It was felt that if these standards were met, most of the other constituents listed in the previous classification would be reduced to a level which would approach the lowest level attainable. These pollutants would include phenols, pesticides, cyanides, most heavy metals, surfactants, oil and grease and others. Those materials, such as mercury, which could not be reduced to acceptable levels, would have to be controlled at the source. These constituents could be more easily determined after pilot plant investigations had been concluded prior to full-scale implementation. The treatment system would be designed to meet these goals 90 percent of the time and never to exceed twice the listed goals.

TABLE 9

EFFLUENT QUALITY STANDARDS

BOD	4 mg/l
COD	10 mg/l
Suspended Solids	2 mg/l
Total Phosphorus	0.1 mg/l
Ammonia Nitrogen	0.3 mg/l
Total Nitrogen	3.0 mg/l

The stated goals imply a high degree of reliability. Systems must be designed to treat to the standards listed when operating at the maximum hydraulic capacity. This would require consideration of both maximum wastewater flows and flows from within the system (e.g. Filter Backwash Water, thickener supernatant, sludge recycle, etc.) Also, consideration would have to be given to such items as: auxiliary fuel, power, and chemical sources, replication of units; and flood protection.

The State of Michigan, through the Water Resources Commission, has established effluent criteria for municipal wastewater plans. In general, plants located along the Great Lakes and connecting channels would be required to provide secondary treatment and 80% phosphorus removal. Plants located on inland rivers and streams would have more stringent requirements, depending upon the character of the waste and the receiving body of water. These are defined earlier in this chapter in Table 3.

It was also necessary to develop criteria for processes resulting in discharge to the atmosphere. All such processes would be required to meet current (or when possible, projected) atmospheric emission standards defined by the State or by the Environmental Protection Agency.

Other items to be considered in design were occupational health and safety, multiple-use opportunities, and aesthetics.

PLANNING ASSUMPTIONS

Some planning assumptions were selected before starting the plan formulation process. These assumptions have been shown, by current plans for the study area, to be an effective and acceptable method of providing water and sewerage facilities to the region. These assumptions became planning constraints in line with the stated study objective that ongoing short term water resource plans would not be interferred with. They were separated into five broad categories consisting of: industrial wastewater, rural wastewater; resources availability; base or existing facilities; and future water resource opportunities.

Industrial Wastewater

1. Industry will discharge to municipal wastewater systems. Considering the high degree of treatment being studied, control of all point sources is essential.

2. Industry will pretreat its wastewater to remove constituents harmful to municipal system processes.

Rural Wastewater

1. Rural wastewater in southeastern Michigan will be controlled by methods other than those considered herein. As these areas change from rural to urban, however, they will be incorporated into the wastewater systems being considered.

Resource Availability

1. Energy, chemical, and material requirements for construction and operation of the systems will be available.

2. Land requirements for treatment sites, sludge disposal, and storage basins will be available within the planning period. Institutional constraints would not prohibit the acquisition of land for these facilities.

Existing Wastewater Facilities

1. Consistent with the ongoing State of Michigan plans for the study area, the Huron River interceptor system will be built. Later in the study, funding and institutional problems forced the State of Michigan and the USEPA to reexamine the timing of the implementation of this plan, but the decision to build the interceptor system is still valid.

2. Other major collection and transmission facilities in existence in 1975 would form the base system for all alternatives. These systems, together with the Huron River interceptor system, will capture about 85 percent of the municipal and industrial wastewater flows.

Future Water Use Opportunities

1. The Detroit water supply system will be extended to most of the study area. Many communities now using inland streams would switch to this more dependable source.

2. Reuse of treated wastewater for distribution within the existing and expanded municipal system will not be politically or socially acceptable within the planning period.

3. The ongoing State of Michigan plan, Plans for Water Quality Management, Phase II for Southeastern Michigan, would provide the base information for the development of a plan based on state water quality criteria.

Chapter 4

STAGE I--DEVELOPMENT OF ALTERNATIVE COMPONENTS

DEVELOPMENT OF PRELIMINARY DESIGN INFORMATION

Initial investigations were undertaken to develop a range of technical components which could be combined to form complete wastewater management alternatives. The procedure consisted of the review and design of a multitude of wastewater control systems and processes which, when combined, could result in the highest level of treatment at the minimum financial cost. Six areas of wastewater management were investigated. They included three methods of wastewater treatment and three other components which are vital to a total wastewater management system. The six areas investigated and designed were:

1. Advanced (Biological) Wastewater Treatment
2. Independent Physical-Chemical Treatment
3. Land Treatment
4. Stormwater Collection and Storage
5. Collection and Conveyance Systems
6. Sludge Handling and Disposal

These various areas are discussed in the following paragraphs.

Advanced wastewater treatment (also called Advanced Biological Treatment) as used in this report can be defined as a system which uses the conventional preliminary, primary, and secondary biological processes as a base with additional or tertiary processes used to achieve a higher quality treatment.

The preliminary and primary processes remove, by screening and settling, a major portion of the sewage solids. About half of the total pol-

lution load from the wastewater can be removed by these two steps. Secondary treatment is an operation in which biological action is encouraged to promote reduction of dissolved organic materials in the wastewater. This is accomplished by artifically supplying oxygen to bacteria which use the organic matter contained in wastewater as a source of food and convert it to carbon dioxide and water. In the past most wastewater treatment facilities stopped after secondary treatment. (See figure 4.)

In order to achieve the effluent quality goal of this study, however, a high level of tertiary treatment would be required to reduce concentrations of phosphorus, nitrogen, suspended solids, dissolved organic materials, several metallic ions, and other undesirable constituents. Processes which may be used to achieve this advanced treatment include, chemical clarification, nitrification - denitrification, filtration, chemical oxidation, activated carbon adsorption, and several "ultrapurification processes." Many of these processes are identical with those used in independent physical-chemical treatment systems, described below, with the exception of nitrification-denitrification which is a biological process employed for removal of ammonia and nitrate nitrogen. (See Figure 5.)

Independent physical-chemical treatment uses no biological treatment processes. Instead, after receiving normal preliminary treatment, physical and chemical processes are used to reduce the concentration of pollution constituents. (See Figure 6.)

Chemical clarification is employed to separate settable suspended solids from wastewater and to remove soluble phosphorus and metal ions. Dissolved organic matter is removed by activated carbon adsorption. Carbon adsorption replaces the secondary biological treatment process and will effectively adsorb those organic constituents for which conventional biological processes are effective as well as many organic wastewater constituents not affected by conventional biological processes. Nitrogen is removed by breakpoint chlorination which oxidizes ammonia nitrogen to

FIGURE 4

SECONDARY TREATMENT

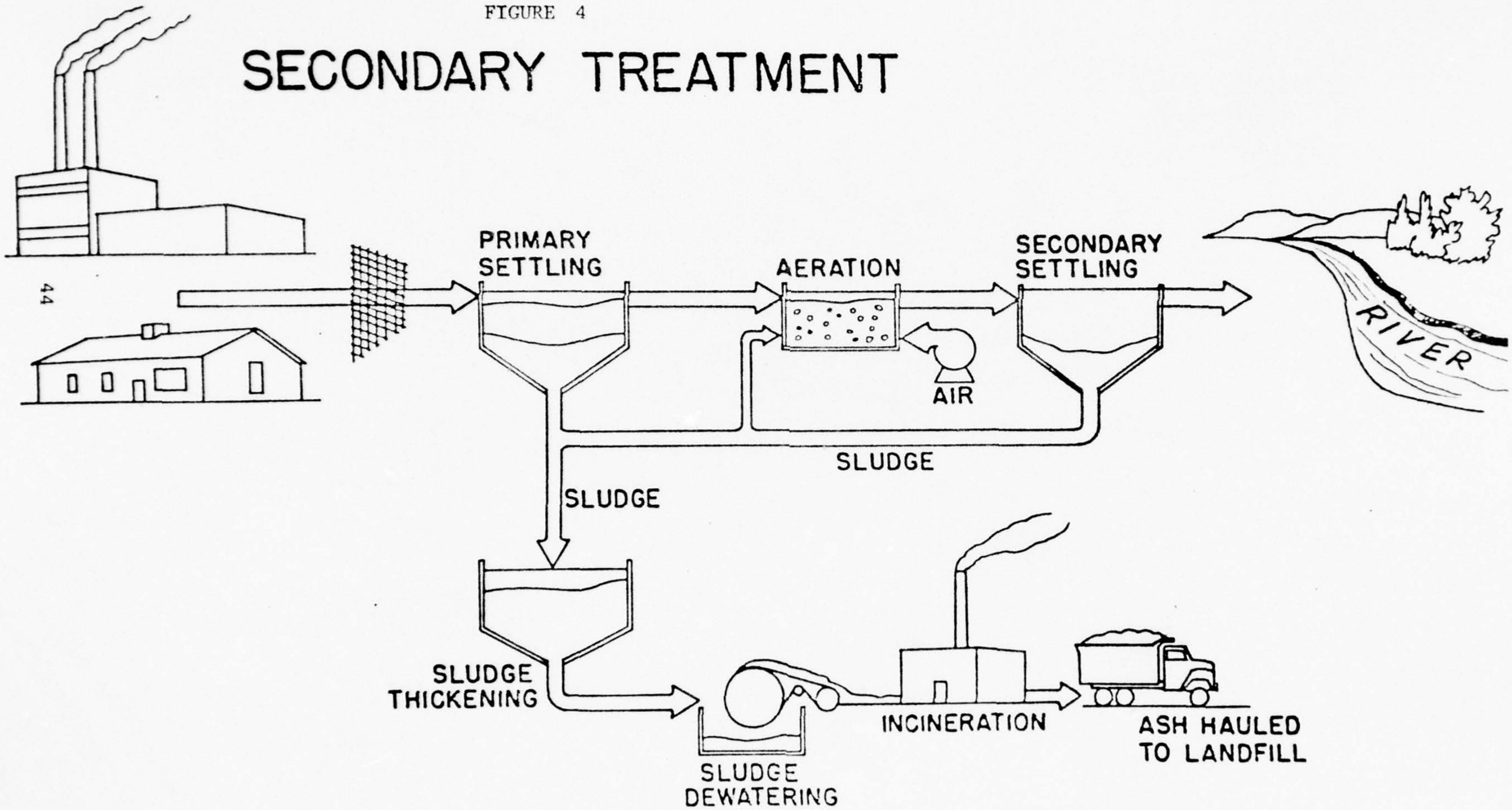


FIGURE 5

AWT PROCESSES

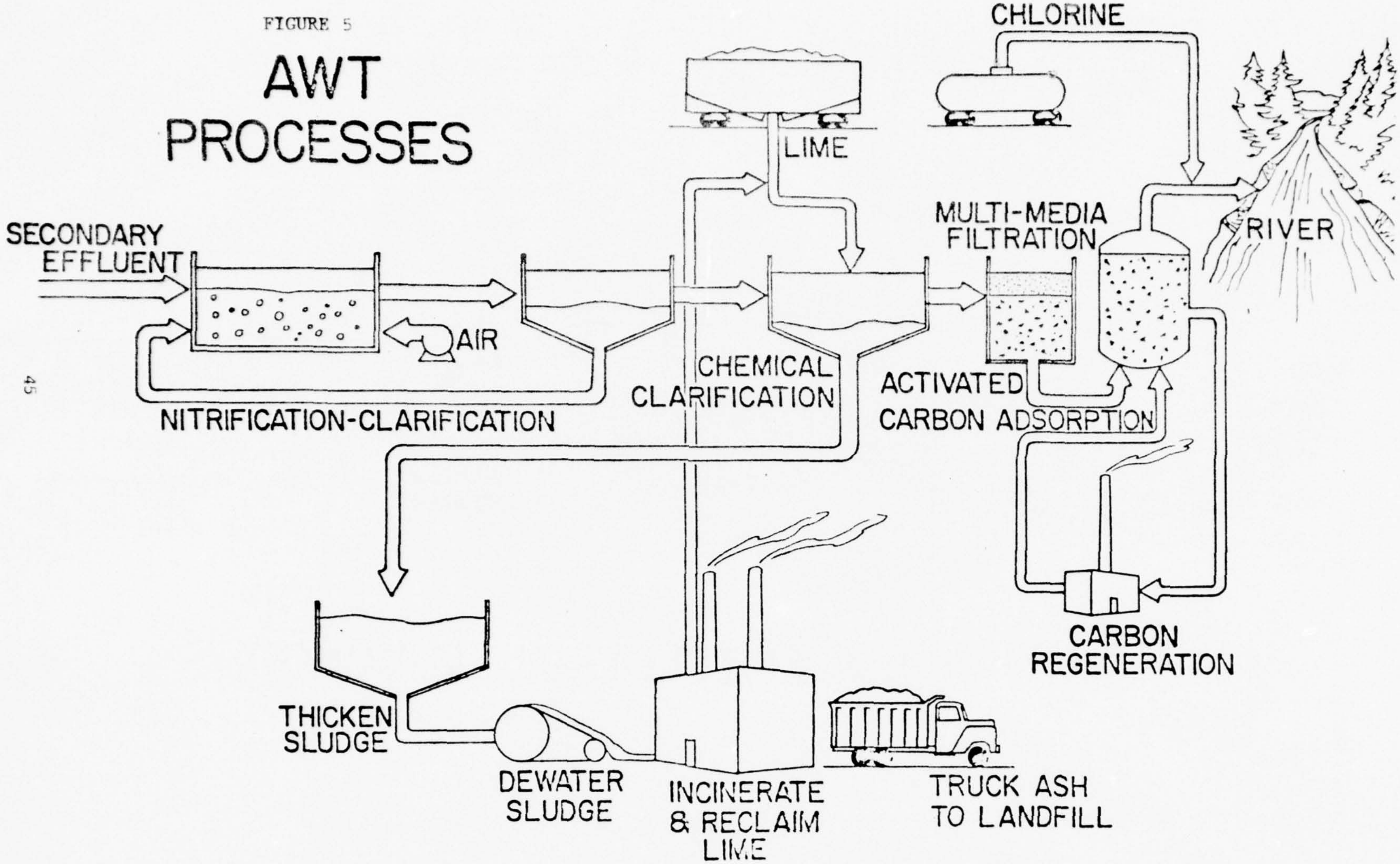
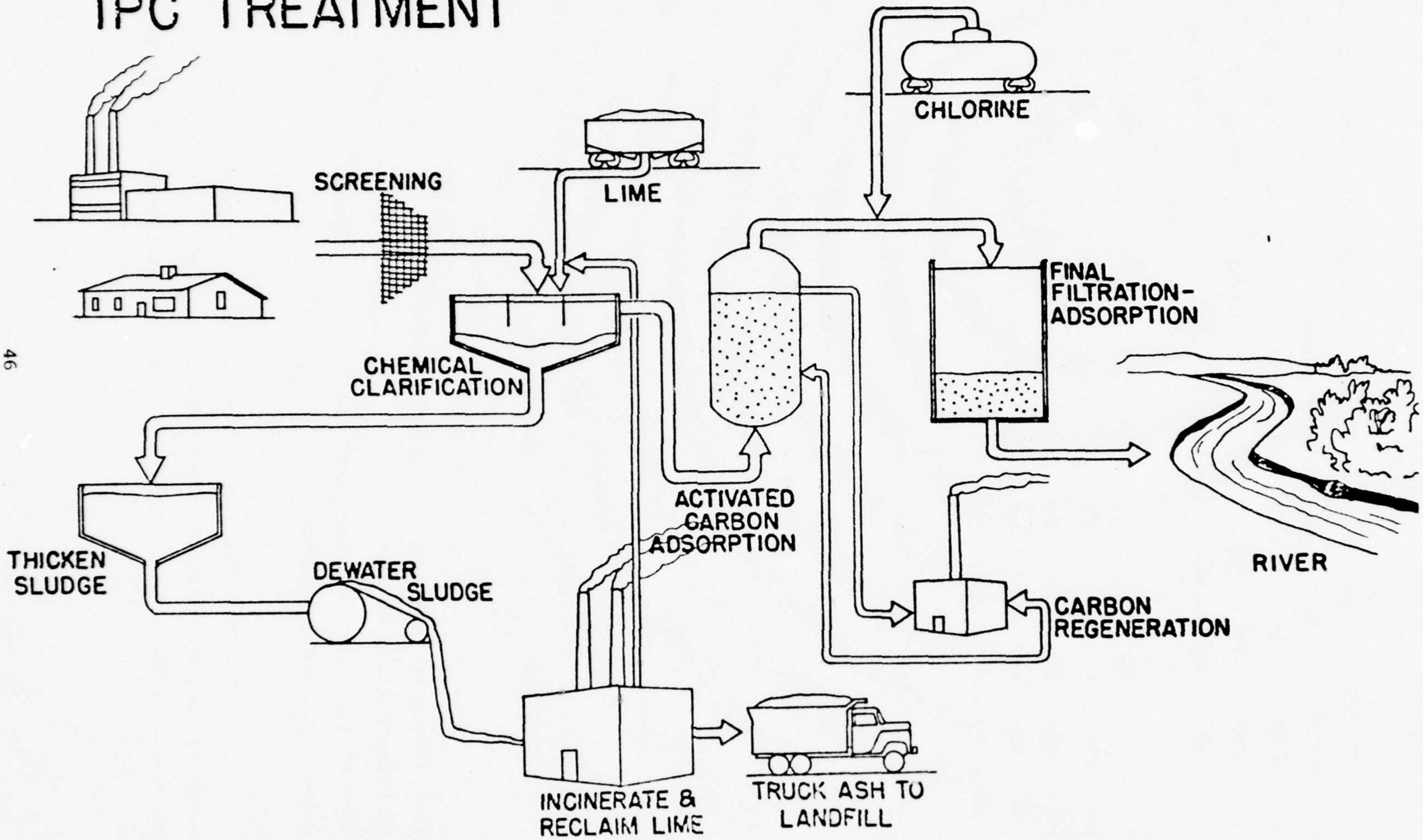


FIGURE 6

IPC TREATMENT



nitrogen gas and also results in a high efficiency of disinfection. Filtration is employed as a final process to remove any of the suspended solids carried over from preceding processes. To obtain economy of design, the final carbon adsorption can be designed as a packed bed, thus allowing it to serve the function of adsorption, filtration, and dechlorination.

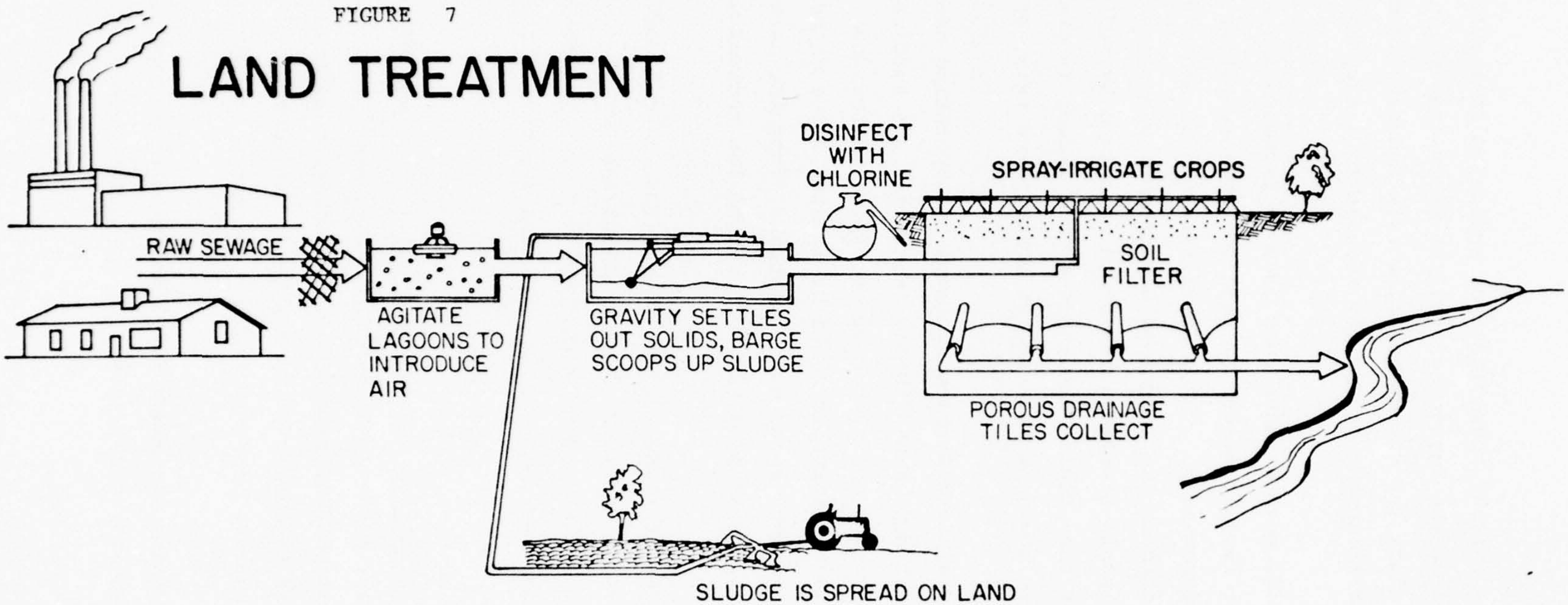
The Land Treatment system for wastewater management allows soil and growing plants to remove potential pollutants found in wastewater. Land treatment utilizes the natural processes of the earth's soil zone and the growing crops, relying on the existing soil biota, the soil filtering capacity, and the chemical exchange ability of the soil, to retain the nutrients for uptake by the crops. The effect is to recycle back to the environment those substances necessary to nature, but discarded as pollutants by man.

Pretreatment facilities and treatment lagoons prepare the wastewater for land application. Treatment lagoons provide the equivalent of secondary treatment prior to land application. Micro-organisms in the lagoon feed on the organic matter and reduce the degradable organic content to an acceptable level for storage lagoons. Storage lagoons are provided since wastewater can only be applied to the land during certain periods of the year in this area. They also act as settling basins and stablize the remaining BOD. Disinfection facilities are provided at the outlets to limit the spread of potential disease organisms. (See figure 7.)

A stormwater collection and storage system was developed to control the effects of pollution from urban stormwater runoff. As the other sources of urban wastewater, municipal and industrial, are controlled, the proportion of the total pollutant load contributed by stormwater would increase without similar regulation.

Urban stormwater runoff consists of discharges from separate storm sewer systems and overflows from combined sewers. Due to the large initial volumes of stormwater to be treated and the intermittent nature of storm-

FIGURE 7


LAND TREATMENT
RAW SEWAGE
AGITATE LAGOONS TO INTRODUCE AIR
GRAVITY SETTLES OUT SOLIDS, BARGE SCOOPS UP SLUDGE
DISINFECT WITH CHLORINE
SPRAY-IRRIGATE CROPS
SOIL FILTER
POROUS DRAINAGE TILES COLLECT
SLUDGE IS SPREAD ON LAND

water runoff, initial investigations indicated that collection and storage systems would be the key to controlling stormwater pollution. These systems would reduce the stormwater flow rate and make it more receptive to sophisticated treatment before its release to a natural water body.

Several methods have been used or proposed for stormwater storage. Small storage facilities can be used to store runoff from individual developments or communities. These facilities can be above ground or below ground depending on the amount of development and space available in the area. These small storage areas could be served by individual treatment facilities or they could be connected to a larger treatment facility and the wastewater could be released at a specified rate for treatment.

Large size collection systems, incorporating deep tunnels built in hard rock at depths of 250-350 feet below the surface, could be used for partial storage and conveyance of overflows to regional storage facilities. Regional storage reservoirs could be located above or below ground, depending upon the advantages at each location. From the large regional reservoir the water would be treated and released to the natural water system.

In some existing collection systems, such as Detroit, a substantial amount of storage capacity already exists and can be controlled by gates and inflatable weirs. This would provide for selective prevention of spills and overflows and help control the wastewater flow rate to existing treatment facilities.

<u>Collection and conveyance systems</u> transport the water borne wastes from municipal, industrial, and stormwater sources to treatment sites in a complex arrangement of underground transmission lines. These systems are often the most expensive part of a total wastewater management system; consequently, their importance cannot be taken lightly.

Throughout the study area, municipalities have local sewerage systems, interceptors, and trunks or mains. These sewerage facilities are

advantageous to the development of a regional wastewater collection and transmission system, since the existing networks only have to be evaluated and augmented to meet the proposed treatment plant configurations.

Conveyance systems transport large quantities of water from one point to another. The systems may be in the form of open channels, gravity interceptors, force mains, or deep tunnels. The conveyance systems needed for this study would transport wastewater from equalization lagoons to land treatment sites, convey renovated water from land treatment sites to discharge points, convey treated water from lagoon treatment systems to isolated irrigation sites, and transport raw wastewater from significant collection points to treatment plants or lagoon treatment sites.

Sludge handling and disposal is a critical portion of the design of any wastewater treatment system and the final design is not usually selected without extensive bench and pilot scale investigations at the proposed plant site.

All wastewater treatment methods investigated would produce a sludge of some type, and the method by which sludges would be handled or disposed must be weighed in the evaluation of a treatment method. Although sludge characteristics vary somewhat with different treatment methods, alternatives for disposal are limited. The three methods investigated were sanitary landfill of partially dry sludge, incineration (or in the case of lime sludges, recalcination) and land application. Power consumption, resource requirements, land use considerations, ecological effects, and economics developed in these investigations will be important items to be considered in the selection of the final design.

Sanitary landfill of partially dewatered sludge would follow the procedures established for solid waste sanitary landfills. The sludge

material would first be dewatered, using filters or centrifuges, and then filled and covered, resulting in alternating layers of sludge and earth. A fill area would be specially prepared and maintained to limit water percolation through the fill and prevent direct contract with ground water aquifers.

In the incineration and recalcination processes, sludge is burned at temperatures of 1500-1700°F. Fuel would be required to maintain furnace temperature and insure complete combustion. Afterburners and emission control equipment would be a necessity to prevent excessive air emissions. Ash from incineration of wastewater sludges would be relatively inert and could best be disposed of by landfill. Lime clarification sludges, when recalcined, can yield significant quantities of reusable lime.

Sludges can also be applied to lands and utilized for their agricultural value. Although raw sludge can be applied directly, initial decomposition may have toxic effects on plants. Digested sludges reduce the possibility of this problem. Sludges may be plowed into the soil as a liquid or partially dry solid, or it may be applied in trenches as a partially dry solid. The final alternative allows high rates of initial application while the first two would require lower rates over a longer period.

DEVELOPMENT OF TECHNICAL COMPONENTS

As was pointed out in the previous sections of this chapter, a multitude of technical processes and facilities exists which can be combined to form wastewater management systems. The second portion of stage one was the actual design of technical systems and facilities for various locations throughout the study area. These became the technical components which were combined in stage two to form total wastewater management alternatives.

The development of these components took place in relation to the six areas mentioned at the beginning of the chapter.

The following paragraphs document the key decisions made in the technical development of these six areas.

Advanced Wastewater Treatment Chronology

NEED FOR TREATMENT BEYOND CONVENTIONAL SECONDARY LEVEL IS EMPHASIZED - Ecological assessments conducted during the Feasibility Study indicated that if conventional secondary treatment were employed, the water quality of the area would not be changed significantly enough to retard the degradation of Lake Erie.

ADVANCED WASTEWATER TREATMENT (AWT) IS INVESTIGATED BECAUSE OF ITS ABILITY TO MEET EFFLUENT REQUIREMENTS AND ITS ECONOMIC ADVANTAGES - The AWT process was one of three systems investigated because effluent requirements could be achieved by up-grading existing biological systems. The use of these existing facilities takes advantage of the previous economic investment made by many communities in primary and secondary treatment systems.

THE SELECTION OF PLANT LOCATIONS IS MADE - Based on current plans for the study area and the existing plants and facilities in the area, locations of major plants which could be combined to form a regional system were selected. Plans used included the Detroit Metropolitan Water Service Regional Watershed Plan, the State of Michigan plans for Water Quality Management, Southeast Michigan Council of Governments Regional Water, Sewerage and Storm Drainage Facilities and Plans, numerous county and municipal plans, and information obtained during the Feasibility Study. During the initial investigations the following designs and alternatives were developed. Flow projections for these plants were based on population projections and industrial water use projections for the area.

Plant Location	Flow (MGD)
Detroit	806
Algonac	4.1
Algonac	24.5
Monroe	99.6
Huron River	571
Huron River	471.4
East China Twp.	8.2
Port Huron	12.3
Adrian	4.42

MINOR PLANTS ARE TO SERVE PORTIONS OF STUDY AREA NOT SERVED BY REGIONAL SEWER SYSTEMS - The study area includes all or portions of nine counties. Outside of the metropolitan areas, there are smaller communities that have a wastewater treatment responsibility. This wastewater is a relatively small amount of the total wastewater flow of the area, but should also be controlled. These flows would best be handled by smaller sized or minor treatment plants. Many of these plants are considered

interim facilities and would provide treatment until the amount of urban growth in the area justifies further extension of the regional interception system. The location of these plants would be identified, but specific design of a system to serve each location would not be undertaken.

EXISTING MAJOR PLANTS FOR PROPOSED UP-GRADING ARE TO BE EXAMINED - In order to obtain firsthand information on the existing plants that were chosen for up-grading, some of the plants were visited by the Corps and the Contractor. They included: Port Huron, Algonac, Detroit and Monroe. Information on proposed plants and other existing plants was obtained from design outlines and detailed plans and specifications.

STORMWATER TREATMENT FACILITIES ARE TO BE SEPARATE FROM M&I FACILITIES - Investigations show that stormwater facilities would have to be maintained separately from municipal-industrial facilities in order to maintain a high reliability of treatment. The variation in stormwater flows would make it impossible to operate biological processes on an intermittent basis; therefore, physical-chemical processes alone would be used for stormwater treatment. These facilities could be located at the same site or at alternate locations.

ANY STATE WATER QUALITY ALTERNATIVE IS TO BE ADAPTED FROM A CONCURRENTLY DEVELOPED STATE PLAN - Meetings with the State of Michigan Water Resources Commission personnel revealed that a plan was being developed concurrently for Wastewater Management in Southeastern Michigan that would be similar to a Corps' alternative to meet State water quality. In order to eliminate duplication of effort it was agreed to by the Corps and the State that any alternative to meet State water quality would be developed from the information contained in this concurrent plan.

WYANDOTTE TREATMENT PLANT IS TO BE INCLUDED IN DESIGN INVESTIGATIONS - The Wyandotte treatment plant was not included in the Feasibility Study or some original designs because some early plans indicated that the flows from this plant were going to be incorporated into a proposed new plant at

the mouth of the Huron River. During this design process, the question of how the second largest plant in Southeastern Michigan could be overlooked was again raised. Local developments since the Feasibility Study, including the up-grading and expansion of the facilities, showed that the Wyandotte Plant would in fact be a fully operational plant to the year 1990 and most probably after. This led to the late inclusion of the Wyandotte plant into the planning of a regional system.

THE ALGONAC SITE IS ELIMINATED AS A POTENTIAL REGIONAL WASTEWATER TREATMENT PLANT SITE - The existing facility at the Algonac site is basically a primary treatment plant with a design capacity of 3 MGD but with a current average daily flow of 0.3 MGD. The upgrading of the plant to a larger AWT facility would be less desirable than building a new plant at a more centralized location. The layout of the plant would also be more efficient if it were built new. For these reasons, a centralized plant was proposed in East China Township.

LOCATION AND FLOWS FOR MUNICIPAL - INDUSTRIAL PLANTS TO BE DESIGNED IN PHASE II ARE DETERMINED - After visiting the existing plants, talking to the operators, examining the plans for current expansion of many of these plants, and in view of the addition of the Wyandotte plant and the elimination of the consideration of a larger Algonac plant, doubts were raised about the location and flows of some of the other facilities being designed. Consequently, a new set of locations and flows was developed. The municipal and industrial treatment plant locations and their corresponding flows are:

Location	Flow
Adrian Tecumseh & East China (each)	12 MGD
Port Huron	24 MGD
Monroe	40 MGD
Wayne County	125 MGD
Huron River	400 MGD
Huron River	525 MGD
Detroit	806 MGD

STORMWATER TREATMENT PLANTS ARE TO BE DESIGNED FOR SEVEN VARIOUS PEAK TREATMENT RATES - Based on various alternative storage locations for stormwater, peak treatment rates were selected to correspond to peak pump-out rates at the storage sites. The seven stormwater plant peak treatment rates are: 125, 225, 400, 600, 1,000, 1,200, and 1,400 MGD.

TREATMENT OF STORMWATER BY PHYSICAL-CHEMICAL METHODS IS INVESTIGATED - A contract was let to evaluate the effect of "single" and "two-stage" lime treatment on separate stormwater and combinations of separate stormwater and combined sewer overflows. It was concluded that a two-stage lime process would be required when high treatment efficiencies are specified. The lime dosage required, may be as great as 300-400 mgd. A report on this subject can be found in the addendum to the Design & Cost Appendix.

BREAKPOINT CHLORINATION IS TO BE USED IN TREATMENT SYSTEMS - Breakpoint chlorination would be employed in both municipal-industrial wastewater and stormwater treatment schemes. In M&I treatment it would provide a backup system for the removal of ammonia nitrogen, if the biological nitrification process is upset or temporarily out of service. It would also assure a consistently low level of ammonia removal. In the stormwater scheme it will be the primary mechanism for ammonia nitrogen removal.

DESIGN CRITERIA AND COST INFORMATION IS TO BE CONSISTENT FOR AWT AND IPCT SYSTEM SIMILARITIES - Meetings were held between persons involved in the design of AWT systems and persons involved in IPCT designs so that similar processes being used in each system could be discussed. Since many of the processes are currently in operation on a small scale basis, differences in design criteria and curves for projected enlargement of these facilities were discussed and a consistent set of information was agreed upon.

FINAL PLANT DESIGNS BY CONTRACTOR ARE ACCEPTED FOR COMPONENTS IN THE DEVELOPMENT OF SYSTEM ALTERNATIVES - Through continuing cooperation

with the contractor and the exchange of information involved, the designs and information compiled were accepted for use in the development of alternatives. Minor modifications would be required in some cases, but information was provided to make these changes with as little difficulty as possible.

INDEPENDENT PHYSICAL-CHEMICAL TREATMENT TO BE INVESTIGATED - It was recognized that additional treatment processes, which would be necessary to upgrade a secondary treatment plant to achieve the desired effluent quality, could be applied directly to treatment of raw wastewater and that such an application warranted investigation.

IPCT NOT TO BE INVESTIGATED FOR A PLAN TO MEET MICHIGAN STANDARDS - Since a system designed to meet the State of Michigan water quality standards would be used as a basis for comparison with alternative systems designed to approach a no discharge of pollutants standard, optimization of that alternative through investigation of other means of treatment was not considered necessary.

INITIAL DESIGN WORK WOULD NOT BE SITE SPECIFIC - By not designing plants of a particular size for a specific site, a wide range of plant sizes could be designed, establishing relationships of plant construction cost, operation and maintenance costs and land requirements versus plant capacity. By designing plants for constant rate operation, the same plant design could be used for all conditions of peak flow (i.e., If peak flow was two times average flow and average flow was 5 MGD, the plant designed for 10 MGD would be used). This would also allow use of the same design for plants treating storm runoff in addition to normal daily flow.

ADDITIONAL DESIGNS WOULD BE REQUIRED FOR TREATMENT OF STORMWATER NOT COMBINED WITH NORMAL DAILY FLOW - It was realized that a savings might be realized if a separate treatment train were designed specifically for the intermittent flow of less polluted storm runoff.

STORM RUNOFF TREATMENT PLANT DESIGNS DEFERRED - Indications from the contractor designing AWT systems were that independent physical-chemical treatment plants were being designed for stormwater treatment. Duplication of those efforts would not be advisable.

CHEMICAL COAGULATION STUDY REQUIRED - Due to a lack of available data on the ability of chemical coagulation to remove heavy metals from raw wastewater, a preliminary study was considered necessary before a final decision could be made on process selection. A report on this study can be found in the appendix to the backup report Independent Physical-Chemical Treatment for Southeastern Michigan.

SELECTION OF PLANT LOCATIONS AND FLOWS MADE - After review of current plans for the study area, visiting existing plants, talking to operators, and examining current plans for the expansion of many plants in the area, the sites and corresponding flows were selected for IPCT plants to be designed. The plant and design capacities were:

Algonac	4 MGD
East China	8, 12, 36 MGD
Adrian - Tecumseh	22.5 MGD
Port Huron	24 MGD
Monroe	40 MGD
Wyandotte	125 MGD
Huron River	400, 525, 1371 MGD
Detroit	806 MGD

The criteria for site selection were:

a. Compatibility with existing and proposed land use.

b. Availability of necessary utilities and transportation networks.

c. Compatibility with regional plans.

d. Orientation of existing sewer systems.

e. Adaptability of existing process equipment (if any) to the proposed plant.

FINAL DESIGN CRITERIA AND COST INFORMATION STANDARDIZED - Through meetings between those parties involved in design of AWT and IPCT systems, criteria for design and standard cost information were agreed upon. Since IPCT and AWT were similar, it was necessary to use the same basis for cost determination. The information used as a base for developing costs can be found in Appendix A to the backup report, Advanced Wastewater Treatment Facilities for Southeastern Michigan.

TWO-STAGE LIME CLARIFICATION SELECTED - The results of the preliminary coagulation study indicated that only a high pH lime process could remove minute quantities of many heavy metals; thus, two-stage lime treatment with intermediate recarbonation was selected.

FINAL DESIGNS ACCEPTED FOR DEVELOPMENT - The IPCT process proved to be a viable method of achieving the goals of this study. The designs were thus accepted for use in development of total system alternatives.

ALTERNATIVE SLUDGE HANDLING SYSTEMS TO BE CARRIED FORWARD IN TOTAL SYSTEM DESIGNS - Direct landfill of dewatered sludge was considered a viable alternative to incineration, since problems could be encountered in obtaining sufficient fuels for use in combustion processes.

Chronology For Design Of Land Treatment Alternatives

LAND TREATMENT OF WASTEWATER TO BE INVESTIGATED - It was felt that the use of land irrigation treatment would be advantageous because

of its capabilities of meeting the high quality effluent requirement, and because it offered the opportunity for an economic benefit in the form of increased agricultural production.

THE LAND TREATMENT SYSTEM WAS NOT DESIGNED TO MEET THE STATE OF MICHIGAN WATER QUALITY CRITERIA - A properly designed and operated Land Treatment System could perform much better than the criteria set up by the State. The use of the Land Treatment method presupposes that the dissolved nutrients and other substances not annually removed in secondary treatment in the wastewater will be removed by a combination of soil adsorption and crop uptake.

SELECTION OF TREATMENT AREAS - Land Treatment was separated into two parts for its design in the initial efforts. The irrigation and collection systems that would provide advanced waste treatment to Southeastern Michigan's wastewater were first designed. Another portion included both the design of transmission systems to transport the wastewater from designated collection points to the Land Treatment Areas, and the design of treatment and storage lagoons. These treatment and storage lagoons would provide the equivalent of both primary and secondary treatment.

During the initial investigations, the following irrigation areas were designed. Flow projections for these irrigation areas were based on population projections, industrial and municipal water use projections, stormwater runoff projections, and the predicted renovative capacity of the various soil types used.

Treatment Site	Area (Square Miles)	Yearly Design Inflow @ 2"wk for 35 wks/yr (MG)	Daily Flow @ 365 days/yr (MG) *
Huron-Tuscola	611	706,035	1,934
St. Clair	375	432,934	1,186
Monroe	83	95,564	262
Lenawee	37	42,550	117
Williams-Fulton	272	314,040	860

*This figure was used for relative magnitude only. Since irrigation would be accomplished during a period of 35 weeks, it would be necessary to establish an equivalent daily rate at a later period.

MINOR PLANTS TO SERVE PORTIONS OF THE STUDY AREA NOT SERVED BY REGIONAL SEWER SYSTEMS - The Study Area included all or portions of nine counties outside the metropolitan areas. As mentioned in preceding sections, there are smaller communities that will have individual wastewater treatment in the year 2020. In the Land Treatment Disposal system these communities would still have their wastewater flows treated either in small plants until their growth could justify their joining a regional wastewater system, or, as might be likely, they would choose to operate their own independent Land Treatment systems.

DETERMINATION OF SOIL CRITERIA - In the Land Irrigation Treatment Method, two criteria were used. First, the land had to be able to accept the water; so, a sandy soil was needed. However, a major portion of the nutrient (Phosphorus, Nitrogen) removal is accomplished by the absorption onto "clay" type soils. It was necessary, then, to find a soil which exhibited the desireable qualities of both clayey and sandy type soils. This led to the use of loamy type soils in the initial investigations, since it satisfied both the percolation criteria which called for sandy soil and the nutrient removal characteristic of clayey soil.

THE LAND TREATMENT SYSTEMS DEVISED IN THE INITIAL PORTION OF THE STUDY WERE ALL-INCLUSIVE - An attempt was made to use all of the land that had been determined to be suitable for wastewater renovation. A determination of costs of the Land Disposal Systems was made. This included the costs of land acquisition, family relocation, legal costs, woodland clearing, and site preparation. The costs of installing irrigation equipment and the treatment, storage, and transmission costs incurred before irrigation were also included. It was quickly apparent that enough land was available for wastewater renovation in the general Southeastern Michigan region. It was therefore ruled that, while the Williams-Fulton (Ohio) site would receive further study, the political problems caused by transporting wastewater across a State boundary would prove to be more detrimental than could be offset by any treatment benefits derived.

IRRIGATION MODULE DECISION - In the initial investigations, a series of four square mile irrigation modules was designed. These modules detailed the various means of applying the wastewater to the lands, along with the accompanying costs of these systems. Irrigation modules, detailing center pivot rigs with 76% land coverage, 91% land coverage, and 95% land coverage, were designed. Irrigation modules, showing details of fixed set spray systems and Graded Border Irrigation Systems, were also designed. In the Phase II design, a selection of the 95% land coverage center pivot sprinkler system was made. This system, was determined to be the most applicable for many of the agricultural areas in Michigan.

UNDERDRAIN MODULE DECISIONS - Also included in the initial design was a series of underdrain modules. These modules were designed with under-drains on 55 foot centers, on 33 foot centers and on 16-1/2 foot centers. They were designed for construction with or without an impervious asphalt layer constructed beneath them. The accompanying costs of each of these modules was given. The decision was made to use the underdrain module with underdrains on 33-foot centers. This module was selected for use without an impervious asphalt layer.

DESIGN OF TRANSMISSION SYSTEMS AND ROUTES - The determination was made that the transmission systems would, as far as possible, be designed along existing State or Federal Highway routes. This would negate the cost of obtaining rights-of-way from private owners. Other parameters decided upon were the use of deep tunnels in bedrock for much of the designed transmission system. Generally, the use of conduits, 10 feet in diameter and above, in urban areas, necessitated the use of these deep tunnels. For conduits of lesser diameter, "shallow tunnels" or "cut and cover" conduits would be constructed.

THE COMPONENTS DESIGNED IN THE LAND TREATMENT STUDY WERE USED AS THE BASIC "BUILDING BLOCKS" FOR COMPLETE LAND TREATMENT SYSTEMS - First, a "Total Land Treatment System" was designed. This system consisted of lagoon treatment areas located in Monroe and St. Clair Counties, with connections to irrigation areas in the Huron-Tuscola County Area, the St. Clair County Area, the Monroe County Area, and the Lenawee County Area. Other systems were also designed, again using the data generated in the initial portions of the study. The use of these systems presupposed the use of other modes of treatment for some of the wastewaters of the Region. For example, if the Detroit Sewage Treatment Plant, the Wayne County Road Commission's Wyandotte Plant and the Monroe Treatment Plant were to be operated as secondary treatment plants with phosphorus removal, perhaps the additional wastewater flows in the area could be treated in small land disposal areas.

Chronology For Stormwater Collection & Storage System

NEED FOR COLLECTION & TREATMENT OF POLLUTION FROM STORMWATERS - The Feasibility Study pointed out the need for collection and treatment of stormwater which is currently being allowed to flow untreated to the surface

waters of the area. It also showed that storage systems would have to be developed and that they would be the key to the amount of control achieved. Additional investigations have shown that the total pollutant load contributed by stormwater sources is a function of the amount of water being allowed to flow freely to a receiving stream without treatment. This reinforces the fact that the amount of storage provided controls the pollution from stormwater sources.

The City of Detroit, with the aid of E.P.A. grants, is working on storage and control techniques to minimize overflow from major combined sewers.

The State of Michigan is currently developing plans to minimize combined sewer discharges for all southeastern Michigan.

SEPARATION OF STORMWATER AND MUNICIPAL-INDUSTRIAL WASTEWATER SYSTEMS - Because of various differences between the wastewaters, stormwater would be handled in a separate system than M & I (i.e., different pollutant concentrations, uniform flow vs. variable flow and physical size of collection system). The current practice in the area is to build stormsewers separate from M & I Systems.

STORMWATER COLLECTION AND STORAGE SYSTEM WOULD BE DEVELOPED SEPARATE OF STORMWATER TREATMENT SYSTEM - A stormwater storage and collection system would be needed regardless of which method of treatment would be used. Wastewater would be conveyed from storage areas to treatment sites after flows had been stabilized, thereby reducing pipe and pumping costs. The Feasibility study showed that in buildup areas, a new collection system would have to be at lower elevations than existing collection systems.

DEVELOPMENT OF A SCOPE OF WORK FOR SURVEY SCOPE STUDY TO INCLUDE FIVE SYSTEMS - Additional investigations into information used in the Feasibility study and more recent information on methods of controlling pollution caused by storm runoff led to an approach whereby five systems would be considered. These systems were:

a. Collection by low velocity, large size, deep tunnel interceptors with storage in the tunnels.

b. Collection by moderate velocity, smaller size, deep tunnel interceptors leading to large underground storage areas.

c. Storage in localized temporary surface storage facilities with a conveyance system leading to central treatment points.

d. Storage in localized temporary surface storage facilities which would permit treatment using small "package" treatment plants.

e. A combination of the aforementioned systems using the best system of each service area considered.

THE TECHNICAL AND ECONOMIC FEASIBILITY OF SYSTEMS BASED ON THE TOTAL USE OF DEEP TUNNELS OR TEMPORARY SURFACE STORAGE FACILITIES IS QUESTIONED - The initial investigations indicated that not enough land is available for temporary surface storage facilities in the urban portion of the study area. And, even if the land could be purchased for this purpose, the cost would be greater than the tunnel concept. Land is available, however, in the outlying areas and it is more economical to build storage facilities above ground than to build tunnels and mined storage areas. In some areas of the study, one of these concepts was clearly more advantageous. More detailed analysis were performed in areas where either method could be used.

SERVICE AREAS WERE SELECTED - Based on the latest Southeast Michigan Council of Governments (S.E.M.C.O.G.) drainage and sewage maps, and projected sewer areas, and the natural drainage basins of the area, service areas were selected. Major collection and conveyance networks would follow natural drainage systems and transportation corridors.

By following the natural drainage systems a new system would serve as a relief drain to the large number of existing storm sewer drains and combined sewer overflow pipes which have been designed to discharge into local inland streams. The natural gradient of the area slopes toward the Great Lakes system coastline to the east.

Discussions with the State Highway Department and various public officials have shown that acquiring the rights of way for the facilities would be a critical step in the implementation of a stormwater collection and storage system. Since all river beds and a portion of the adjacent flood plain lands are in public ownership, the problem of right of way acquisition would be reduced. The same would be true if these facilities could be located beneath existing highways.

Therefore, both the engineering efficiency and the advantageous real estate right of way situation reinforce a system designed to follow natural drainage and existing transportation corridors.

SELECTION OF INFILTRATION CAPACITY - UNIT HYDROGRAPH METHOD OF PEAK FLOW DETERMINATION FOR SIZING COLLECTION FACILITIES - Various methods of estimating peak flow rates were tested and compared including the rational method, a modified rational method, and an infiltration capacity-unit hydrograph method. Since the infiltration capacity-unit hydrograph method can be used more accurately for determining peak flows from large drainage areas, it was chosen as the design method. It was developed by Dr. E. F. Brater of the University of Michigan from 535 station years of record from streams in Southeastern Michigan. This method has been previously used in the area by the Army Corps of Engineers and others with favorable results.

LOCATION OF PROPOSED MINED STORAGE FACILITIES CONFLICT WITH OTHER MINING OPERATIONS - Solution mining operations, such as brining operations

for salt, in the area south of the Rouge River to Monroe would hamper the safe construction and operation of mined storage facilities in that area. An alternate choice for mined storage was chosen under Lake St. Clair. Geologic information indicated that the area would be suitable for construction. Also, any subsidence, in case of a failure, would have minimal effect on the surface.

SELECTION OF ALTERNATIVE FIVE, WHICH USES A COMBINATION OF SURFACE STORAGE AND MINED STORAGE, FOR FURTHER DEVELOPMENT - Alternative Five would service the area most economically and completely. It would utilize large size deep tunnels with some tunnel storage and mined storage for the urban area. Other storage would be in temporary storage lagoons throughout the suburban area.

REGIONAL SURFACE STORAGE RESERVOIRS INVESTIGATED TO REPLACE SOME OF THE MINED STORAGE REQUIREMENTS - A comparison of the costs of surface storage to mined storage showed that surface storage costs were far below those of mined storage. Although surface storage may be objectionable in terms of land requirements, aesthetics, or some other factor, these factors may not outweigh the economic benefits of the surface storage method.

AMOUNT OF STORAGE TO BE PROVIDED FOR, IS DETERMINED - A complete simulation program was run to determine the amount of storage required to reduce overflows. Various designs were tested against 40 years of records to determine the size and magnitude of the overflows which would have occurred. This information was converted to critical pollutant loads being released to the surface waters and was presented to the ecological evaluators. They evaluated the effect of the total pollutant load released and the maximum pollutant concentration being created at any one time to determine the conditions which would be advantageous to limiting the degradation of the receiving water. The information received from this simulation program was also statistically analyzed to form a family of curves which would

predict the probability of an overflow from systems with specified storage volumes and pumpout rates. Using these analyses, a storage value of 2.1 inches of runoff was chosen. This value produces favorable ecological results and has an overflow probability of just under ten percent. Ten percent corresponds to a level of design equal to the existing facilities in the area.

SITES FOR LARGE REGIONAL SURFACE RESERVOIRS WERE SELECTED - Two general sites were selected for the location of the regional surface reservoirs, each requiring about 2,500 acres of land. One was to be located south of the metropolitan area in Monroe County and the other to the north in Macomb County. These sites were selected because: (1) they were located along the major transportation tunnel; (2) they were close enough to the lake system for discharge; (3) the land is not planned for other development; it is mainly farmland; (4) they are located along utility and transportation corridors; (5) they are located far enough back from the lakes that they would not threaten the ecological balance of these bodies nor present a health or safety problem to humans or wildlife; (6) Independent Physical-Chemical Plants could be located at the sites if desired; (7) enough land was available so that aesthetic designs could be implemented and (8) land treatment lagoons are in close proximity.

INLAND TREATMENT PLANTS FOR STORMWATER TO BE PLANNED - In some cases, streams in the area can be beneficially affected by decreasing their peak flow and increasing their average flow. The location of a stormwater treatment facility on a river so that it would handle the equalized peak flows from storage basins in the area could accomplish this desirable condition at little change in cost over a system which transported this water to a downstream system to be treated.

DETAILED INVESTIGATIONS TO INCLUDE FINAL DESIGN OF FIVE SYSTEMS - Based on the evaluations and information in the initial investigations, the following systems were designed in more detail:

a. Alternatives 1 & 2 would be designed for large size deep tunnel interceptors in the urban areas for collecting and transporting the storm flows to surface reservoirs in outlying areas. The remaining areas would be served by a multiple storage interceptor system in which smaller intermittent storage facilities would be used to absorb peak storm flows. One alternative would have inland treatment plants and the other would not.

b. Alternatives 3 & 4 would be designed to provide mined storage for the urbanized areas and multiple surface storage for sparcely populated outlying areas. One alternative would have inland treatment plants and the other would not.

c. Alternative 5 would have both regional surface storage and mined storage for urbanized areas and multiple surface storage for sparsely populated areas.

THE SERVICE AREA FOR THE STORMWATER SYSTEM WAS BROKEN UP INTO 7 SUBAREAS TO BE IDENTIFIED BY MAJOR INTERCEPTOR ARMS - The interceptor-tunnel network developed in the detailed design. Based on this network, the service area was divided into seven subareas for control.

1) St. Clair Service Area
2) Clinton Service Area
3) Oakland-Macomb Service Area
4) Pontiac Arm Service Area
5) Plymouth Arm Service Area
6) Upper Huron Service Area
7) Lower Huron Service Area

THE NUMBER AND SIZE OF THE MULTIPLE SURFACE STORAGE FACILITIES WOULD BE CHANGED FROM INITIAL DESIGN - Initial designs proposed 217 multiple surface or subsurface reservoirs. For control purposes it was decided to increase the size of these facilities and reduce the number. The criteria was that three would be the maximum number per township. By holding to this criteria the number of reservoirs could be reduced to a more manageable number. It was felt that with such a large number (217) operation and maintenance would become a problem. The safety hazard from children playing at these facilities would be reduced since there would be fewer reservoirs. The integrity of fewer areas would be disturbed.

THE GRADIENT IN THE TUNNEL WHICH PARALLELS THE EASTERN SHORELINE IS MINIMIZED - By minimizing the gradient the water can be stored at either regional storage site at each end of this tunnel. This would add a safety feature to the system by maximizing its storage potential. In an area the size of Southeastern Michigan, storm centers tend to be localized. This storage feature could be very worthwhile.

ALTERNATIVES 3 & 4 DROP OUT - The high economic cost of mined storage was the major factor in the rejection of Alternatives 3 & 4. Minor factors include: time of contruction of mined storage greater than for surface storage; mined storage creates solids disposal problems of mined material; and, the amount of difficulty expected with the operation and maintenance of a large mined storage facility.

ALTERNATIVE 6 PROPOSED - For comparison purposes, a sixth alternative was created from Alternative 5 by introducing inland treatment sites similar to those designed in Alternatives 2 & 4.

ALTERNATIVES 5 & 6 DROP OUT - These alternatives are favorable but they are more expensive than Alternatives 1 & 2. Schemes 5 & 6 offer the

opportunity to reduce peak electrical requirements by forty percent over Alternatives 1 & 2 due to the addition of mined storage. The size of the large regional reservoirs would also be reduced. Local power authorities have indicated that they could provide the peak power requirements of Alternatives 1 & 2; however, the reduction in land would not be significant enough to justify the higher economic cost of these alternatives.

ALTERNATIVE 2 IS SELECTED AND ALTERNATIVE 1 DROPS OUT - These alternatives do not have mined storage. They have large regional surface storage areas and require significant peak power demands during heavy storm periods. If the power supply capabilities of the region should change, Alternatives 5 & 6 may become valid again. Alternative 2 was selected over Alternative 1 because of the provisions for two treatment plants on the inland rivers. Alternative 2 has a lower annual cost and would have a beneficial effect on the streams into which they are discharging.

<u>Collection and Conveyance Systems Chronology</u>

COLLECTION AND CONVEYANCE SYSTEMS IMPORTANT TO REGIONAL CONCEPT OF WASTEWATER MANAGEMENT - Systems of sewers collect and carry the waterborne wastes from industry, municipal, and stormwater sources to treatment sites in a complex arrangement of underground transmission lines. These systems are an integral, and often the most expensive, part of a total wastewater system.

MAXIMUM USE TO BE MADE OF EXISTING COLLECTION SYSTEMS - Two regional collection systems already exist in the area, the Detroit Metro Water Department System and the Wayne County System. These systems collect the major portion of the urban municipal-industrial wastewater in Southeastern Michigan serving 80 communities in 1970. These sewerage facilities are advantageous to the development of a regional system, since the existing networks only have to be evaluated and augmented to meet the proposed treatment plant configurations.

LOCAL SEWERAGE FACILITIES TO BE THE CONCERN OF COMMUNITIES THEY SERVE - Throughout the study area, most of the municipalities have local sewerage systems consisting of laterals and submains. Maintenance of these existing sewers and construction of additional ones to serve additional development within their boundaries will be the responsibility of these local governments. Interceptors, as a part of the regional collection network, would receive these flows at a specified point or points within these areas.

THE HURON RIVER SEWER SYSTEM IS ACCEPTED AS A VIABLE PLAN FOR THE STUDY AREA - The Huron River regional sewer system proposed by the State of Michigan for the rapidly developing portions of the Huron River Basin in Oakland, Washtenaw, and Wayne Counties was accepted as an early planning assumption. Later in the study, funding and institutional problems forced the State of Michigan and the USEPA to re-examine the timing of the implementation of this plan but the decision to build the interceptor system remains valid.

EXPANSION OF THE DETROIT REGIONAL COLLECTION SYSTEM TO FOLLOW CLOSELY WITH THEIR CURRENT PLANS - The Detroit Metro Water Department has a comprehensive plan for expanding its regional system into the rapidly developing portions of Oakland and Macomb Counties. These plans have been accepted as the most viable way of meeting the requirements of expanding the regional system.

LENAWEE AND ST. CLAIR COUNTIES REQUIRE INTERCEPTOR SYSTEMS FOR REGIONAL WASTEWATER TREATMENT - The eastern edge of St. Clair County and area around and between Adrian and Tecumseh in Lenawee County are projected to be developed to the point where regional facilities would be desireable. These would take the place of small plants and septic tanks being used in these areas at present.

CONVEYANCE SYSTEMS TO BE REQUIRED TO MEET MANY OF THE ALTERNATIVES - Conveyance systems are mechanisms which transport large quanities of water from one point to another. The systems may be in the form of open channels, gravity interceptors, force mains, or deep tunnels. These conveyance systems would be required to convey renovated water from land treatment sites to discharge points, to convey treated water from lagoon treatment systems to isolated irrigation sites, and to transport raw wastewater from significant collection points or lagoons. Some of these systems could be designed prior to the development of alternatives but many will have to be designed as the alternatives are being formed since many will be peculiar to one alternative.

Sludge Handling and Disposal Methods Chronology

SLUDGE HANDLING AND DISPOSAL METHODS ARE A CRITICAL PART OF A TOTAL WASTEWATER MANAGEMENT SYSTEM - The ultimate disposal of sludges is a critical portion of a regional treatment system for Southeastern Michigan. Relatively few disposal sites are available within the immediate vicinity of the urban area. Trade-offs involving economic costs, energy and land use, ecological and institutional considerations are the key factors in the selection of a sludge treatment method.

EIGHT METHODS OF SLUDGE HANDLING AND DISPOSAL ARE CHOSEN FOR INITIAL INVESTIGATION FOR USE IN SOUTHEASTERN MICHIGAN - In view of existing methods of sludge disposal currently being used, the disposal sites in the area, and the transportation networks available, the following handling and disposal methods were investigated.

1. Pumping raw (unconditioned) sludge from treatment to disposal site for dewatering and disposal.

2. Trucking raw sludge from treatment to disposal site for dewatering and disposal.

3. Rail transport of raw sludge from treatment to disposal site for dewatering and disposal.

4. Pumping conditioned sludge from treatment to disposal site for dewatering and disposal.

5. Trucking conditioned sludge from treatment to disposal site for dewatering and disposal.

6. Rail transport of conditioned sludge from treatment to disposal site for dewatering and disposal.

7. Trucking dewatered sludge or incinerator ash from treatment to disposal site for disposal.

8. Rail transport of dewatered sludge or incinerator ash from treatment to disposal site for disposal.

MOST COST EFFECTIVE TRANSPORTATIONS FOUND - The initial investigation of the above method of sludge handling and disposal showed that when considering landfill disposal, the most cost effective transportation method for all treatment plants in the study area consists of trucking either dewatered sludge or incinerator ash. If surface spreading of stabilized sludge is utilized as the ultimate disposal technique, pumping and pipeline transportation is the most efficient approach.

CHEMICAL SLUDGE HANDLING AND DISPOSAL METHODS ALSO CONSIDERED - Chemical sludge generated by the two stage lime-clarification treatment of both municipal-industrial and stormwater involves many of the same factors previously discussed. An additional factor, however, is the possible recalcination of lime sludge and reuse of lime.

AIR POLLUTION AND ENERGY CONSUMPTION CONSIDERED WITH RESPECT TO RECALCINATION - Recalcination of sludge creates a possible source of air pollution and requires consumption of fuel resources. This factor is offset by the air pollution and fuel requirements necessary for calcination of limestone to produce new lime for the treatment process if recalcination is not practiced.

LANDFILL CHOSEN AS ULTIMATE DISPOSAL METHOD FOR CHEMICAL SLUDGES - Landfill and land spreading were examined as ultimate disposal methods for chemical sludges, but the latter was eliminated from consideration due to the large land area required to permit a satisfactory sludge loading rate.

RECALCINATION AND DEWATERING, BOTH VIABLE ALTERNATIVE SLUDGE HANDLING METHODS - Recalcination and dewatering of chemical sludges have advantages and disadvantages which cannot clearly make one method more favorable than the other. The land savings and lime reuse aspects of recalcination are balanced by its increased energy consumption and air pollution potentials. The energy and air pollution benefits of dewatering are balanced by the increased land use and hauling requirements of the dewatering process.

THREE METHODS OF SEWAGE SLUDGE HANDLING AND DISPOSAL ARE CONSIDERED MOST FEASIBLE FOR SOUTHEASTERN MICHIGAN - A number of economic, land use, ecological and insitutional considerations led to the choice of the most feasible methods of sludge handling and disposal for Southeastern Michigan. They are:

1. Landfill of dewatered sludge.

2. Landfill of sludge ash following incineration.

3. Surface spreading of dewatered sludge.

METHODS OF SLUDGE HANDLING AND DISPOSAL ARE RECOMMENDED FOR SEVEN AWT PLANT LOCATIONS - The following sludge handling and disposal methods were chosen for AWT plants at these locations.

1. Adrian-Tecumseh - landfill of dewatered sludge, because sufficient land is available in close proximity to the plant and the sludge volume is not as great as from the urban plants.

2. Port Huron - landfill disposal of dewatered sludge, because sufficient land is available in the area and incineration would not be feasible at the present plant location because of space limitations.

3. Monroe - landfill disposal of ash following incineration, because suitable sites for disposal of dewatered sludge are not readily available in the area of the plant.

4. Wayne County - landfill of ash following incineration, because the facilities for incineration are available and there is limited land in close proximity to the plant for disposal of dewatered sludge.

5. Mouth of the Huron River (400 MGD & 525 MGD) - landfill of ash following incineration, to reduce the volume of the sludge and minimize the solids handling problem, also since there are more sites for disposing of sludge ash in the area than for disposing of dewatered sludge.

6. East China - landfill of dewatered sludge, because there are suitable disposal sites available within economic haul distance and the volume is not prohibitive for this type of operation.

7. Detroit - landfill of sludge ash following incineration, since incineration facilities are currently available, haul distances long, sludge volumes large and because there is a lack of suitable landfill sites which prohibit landfill or landspreading of dewatered sludge.

SLUDGE HANDLING AND TREATMENT METHODS FOR CHEMICAL SLUDGES DETERMINED - The total annual cost for disposal of chemical sludges without recalcination is significantly less than for the recalcination alternative. Land requirements, however, are substantially less for disposal of excess recalcination ash. Recalcination was selected as the method of treating chemical sludged for this reason.

All stormwater treatment plants except the 125 mgd facility located in East China Township will be provided with recalcination facilities. Similarly, all municipal-industrial wastewater treatment plants except the small facilities located at Adrian, Port Huron, and Monroe will utilize chemical sludge recalcination. Dewatering and landfill disposal will be provided for the four facilities without recalcination. Landfill sites will also be required in conjunction with all recalcination plants. Transportation of either recalcination ash or dewatered chemical sludge will be by truck.

SLUDGE HANDLING AND DISPOSAL METHOD DETERMINED FOR LAND IRRIGATION TREATMENT SYSTEMS - Sludges would be dredged from settling lagoons and "plowed under" by the use of a "rollover or deep" plow. This land application method was in keeping with the objective of land irrigation treatment systems to reuse the valuable waste products to enhance agricultural production the land would be located next to the settling lagoons to minimize transportation costs and problems.

Chapter 5

STAGE II - ALTERNATIVES CONSIDERED

DESCRIPTION OF ALTERNATIVES

The previous chapter discussed the initial investigations and the development of technical information which led to the formation of a range of wastewater management alternative components. In this chapter these components are combined to form eleven complete wastewater management considerations, including: wastewater treatment, collection and conveyance, stormwater control, sludge handling and disposal, cost estimates, and estimates of land, chemical, energy and manpower requirements.

Seven alternatives were formed which utilize only one of the three methods of treatment for municipal-industrial wastewater. Alternatives utilizing the same method of M & I treatment resulted from variations in plant locations and sludge handling and treatment methods. The remaining four alternatives were formed by combining the most effective wastewater management components for various parts of the area. This resulted in alternatives which contained a combination of the three wastewater treatment methods.

The alternatives are identified by names which describe the treatment method proposed for municipal-industrial wastewater and include:

Advanced Wastewater Treatment Alternative One
Advanced Wastewater Treatment Alternative Two
Independent Physical-Chemical Treatment Alternative One
Independent Physical-Chemical Treatment Alternative Two
Independent Physical-Chemical Treatment Alternative Three
Land Irrigation Treatment Alternative One
Land Irrigation Treatment Alternative Two

Combination Wastewater Treatment Alternative One
Combination Wastewater Treatment Alternative Two
Combination Wastewater Treatment Alternative Three
Combination Wastewater Treatment Alternative Four

Advanced Wastewater Treatment Alternative One

This alternative utilizes advanced wastewater treatment as the primary method of municipal-industrial wastewater treatment. Storm runoff would be treated by the independent physical-chemical treatment process. Sewage sludges would be dewatered and disposed of by landfill, the most cost effective method as identified by the contractor. Lime sludges would be recalcined and reused. The alternative would make use of four existing regional plants in the area, thereby maximizing use of existing facilities and minimizing loss of treatment effectiveness during the implementation period.

The system would utilize seven regional advanced wastewater treatment facilities, located as shown in Figure 8. The existing plants located at Port Huron, Detroit, Wyandotte and Monroe would be upgraded and expanded as necessary to meet the requirements of the system. New plants would be constructed at East China, near the mouth of the Huron River, and east of Adrian. Additional advanced treatment plants would serve outlying communities until growth and expansion would economically justify the continuation of the regional interceptor network.

Major interceptor construction necessary for implementation of this alternative would include: an interceptor along the St. Clair shoreline in southern St. Clair County, an interceptor along the Detroit River to the Huron River, an interceptor from Ann Arbor following the Huron River to its mouth, and an interceptor following Hannan Road north of the Huron River.

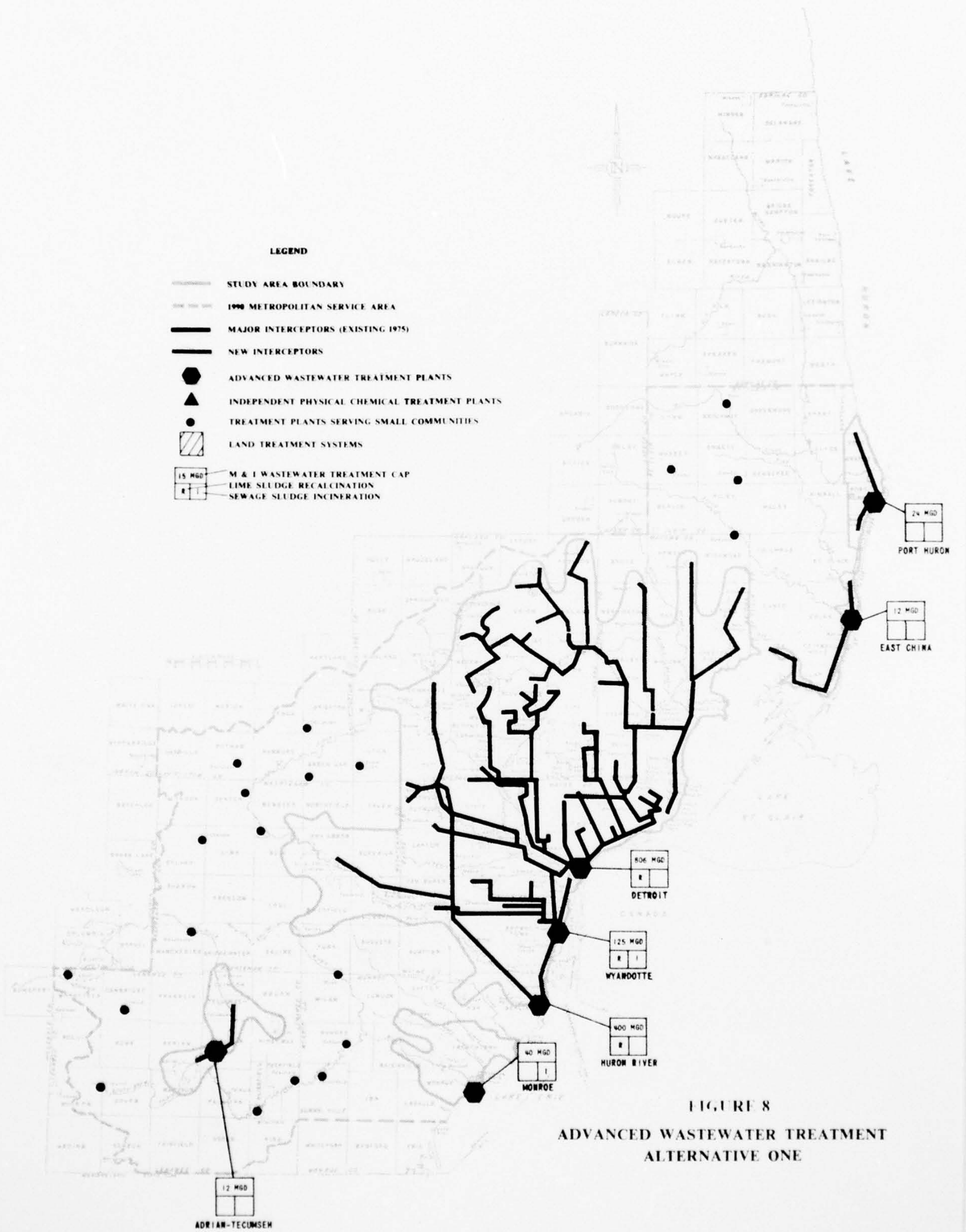


FIGURE 8
ADVANCED WASTEWATER TREATMENT
ALTERNATIVE ONE

The system designed for handling combined sewer overflows and urban storm runoff would be essentially independent of the municipal-industrial wastewater treatment system, see Figure 9. The stormwater system would utilize forty-nine community storage reservoirs ranging in size from 80 to 690 acres. These, and two regional reservoirs of 3,120 acres each, would be used for temporary storage of peak storm flows. Treatment of collected stormwater would be carried out at six IPCT facilities designed specifically for stormwater treatment. Three of these plants would be constructed in conjunction with the municipal-industrial treatment facilities at East China, the Huron River, and Adrian-Tecumseh. These collocated plants would share specific treatment process facilities. The combined use of some of these processes can be made feasible due to the intermittant nature of stormwater treatment. Operation and maintenance workers and supervisory personnel would serve the collocated facility; therefore, the combined work force would be optimized. Another IPCT plant would be located adjacent to the regional storage reservoir in Macomb County to enable greater control of both stormwater system components and minimize disruption which might be caused if these facilities were located at separate sites. The remaining two IPCT plants would be located on the Rouge River at Plymouth and on the Huron River just south of Belleville Lake. These plants would treat the equalized stormwater flows and discharge them into the receiving stream which they would have been part of had they not been intercepted, collected, and treated.

An extensive system of interceptors and tunnels would be required to collect storm runoff and combined sewer overflows at the present points of discharge to surface waters. Normal sewer construction techniques would be utilized in less urbanized areas; however, the greater size of sewers required in highly urbanized areas and the construction problems encountered made design of hard rock tunnels necessary.

Sludges generated by the system would be handled by several methods. Primary and secondary sewage sludges would be incinerated at plants in

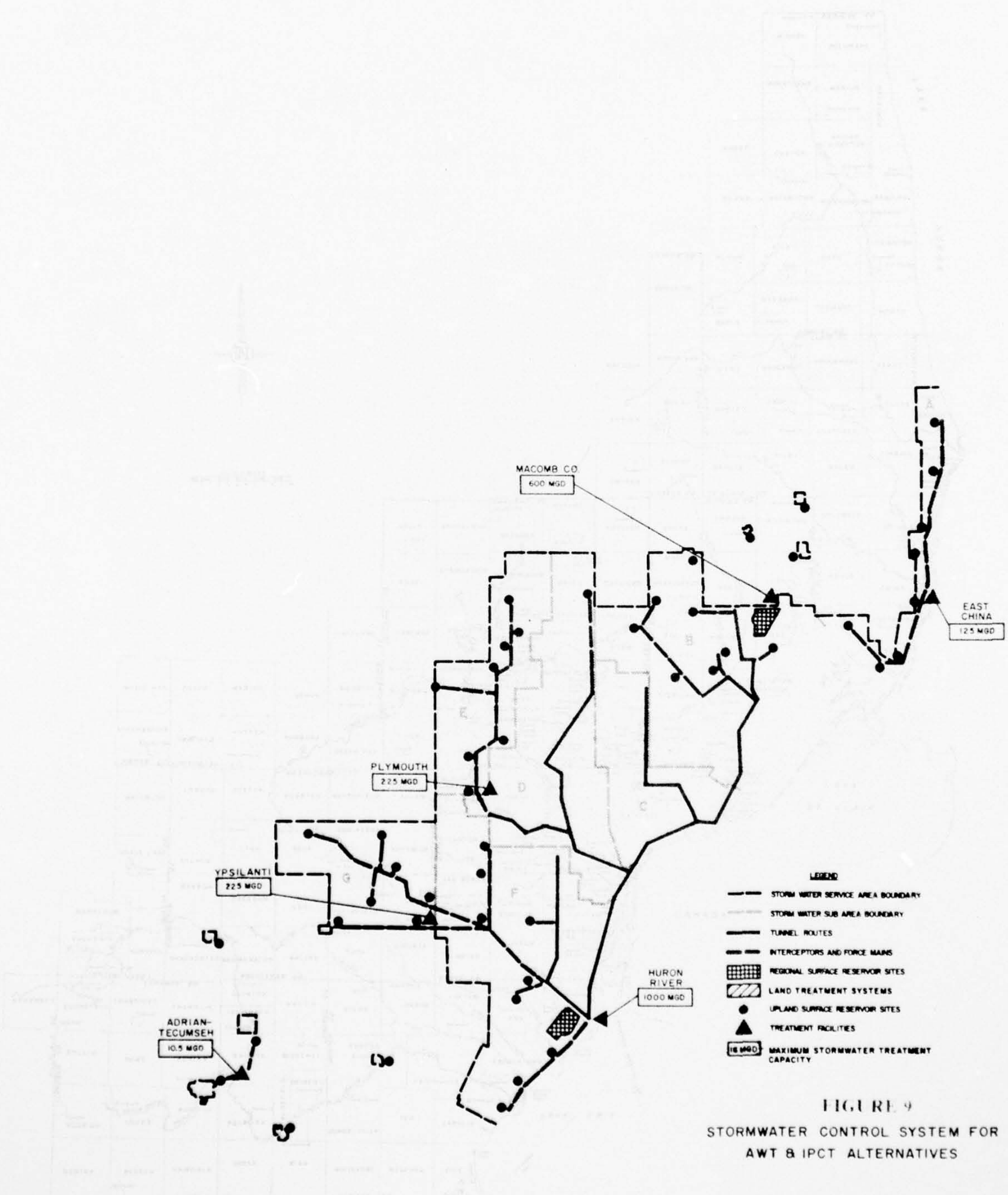


FIGURE 9

STORMWATER CONTROL SYSTEM FOR AWT & IPCT ALTERNATIVES

Monroe and Wyandotte, the ash being disposed of by landfill. The remainder of the sewage sludges would be dewatered and hauled to landfill sites in St. Clair and Lenawee Counties. Lime sludges generated at all treatment plants, with the exception of Port Huron and Monroe, would be recalcined for lime recovery. Sludges not recalcined would be disposed of in landfill areas. A major additional source of waste solids would be the solid material which would accumulate in stormwater storage facilities. That material would be disposed of by landfill, since the low organic content of this material would make it uneconomical to incinerate.

Advanced Wastewater Treatment Alternative Two

This alternative is identical to AWT Alternative One with the exception of the methods proposed for sewage sludge handling, see figure 10. In order to limit sludge hauling and land requirements for disposal, sludge incineration and recalcination would be used extensively. Sewage sludges would be incinerated at the treatment plant sites and the resulting residue would be disposed of by landfill. Incineration of sludge significantly reduces the waste volume and results in a more stable fill material than does the dewatering process. Lime sludges would be recalcined to reclaim the lime and to reduce the waste material. At larger plants recalcination would take place on the site; however, the smaller sized plants at Port Huron, Monroe and Adrian-Tecumseh would not recalcine lime sludge at the plant sites but would haul it to the nearest plant with recalcination facilities. The amounts of lime sludge which would be generated at these smaller plants do not make it advantageous to recalcine on the site; but, with almost no increase in the capital investment for recalcination facilities, the sludge could be treated at the other sites.

The extensive use of sludge, incineration and lime sludge recalcination in this alternative results in various effects on total air emission, energy and chemical requirements, and land use, which are the most significant differences in these two AWT alternative categories.

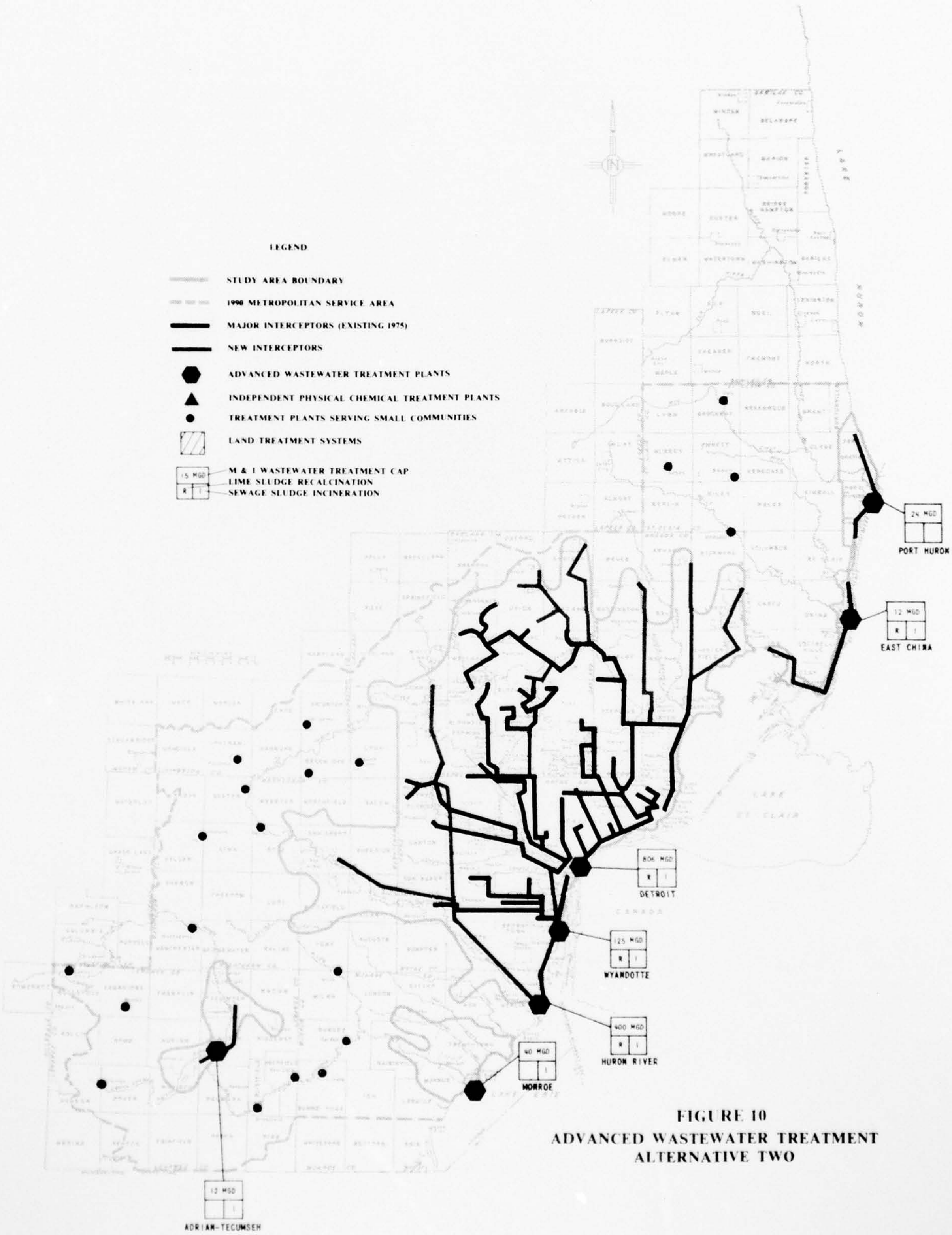


FIGURE 10
ADVANCED WASTEWATER TREATMENT
ALTERNATIVE TWO

Independent Physical-Chemical Treatment Alternative One

This alternative would utilize independent physical-chemical treatment as the primary method for treatment of both municipal-industrial wastewater and storm runoff. Sludges generated during treatment would be incinerated and recalcined lime would be reused. This plan emphasizes centralized treatment and minimum land use, and would abandon all existing regional plants in the area.

Municipal-industrial wastewater would be treated in only three regional plants--the major plant located near the mouth of the Huron River and two lesser plants located in East China and at Adrian-Tecumseh. These locations, as shown in Figure 11, offer large amounts of available land for construction; whereas, several of the existing locations are severely limited for available space. Major interceptor construction necessary for implementation of the plan would include: an interceptor along the St. Clair River shoreline in St. Clair County, a major interceptor from the present Detroit plant along the Detroit River to the Huron River, an interceptor from Ann Arbor following the Huron River to its mouth, and an interceptor following Hannan Road north of the Huron River. Communities outside the area served by the regional plants would operate small advanced treatment plants until growth would justify extension of regional interceptors.

The stormwater control system would be identical to the system described under AWT Alternative One and shown in Figure 8. The collocated facilities at East China, the Huron River, and Adrian-Tecumseh would vary slightly because the M & I wastewater would be treated by IPCT processes and the size of the M & I plant at the Huron River would be significantly larger.

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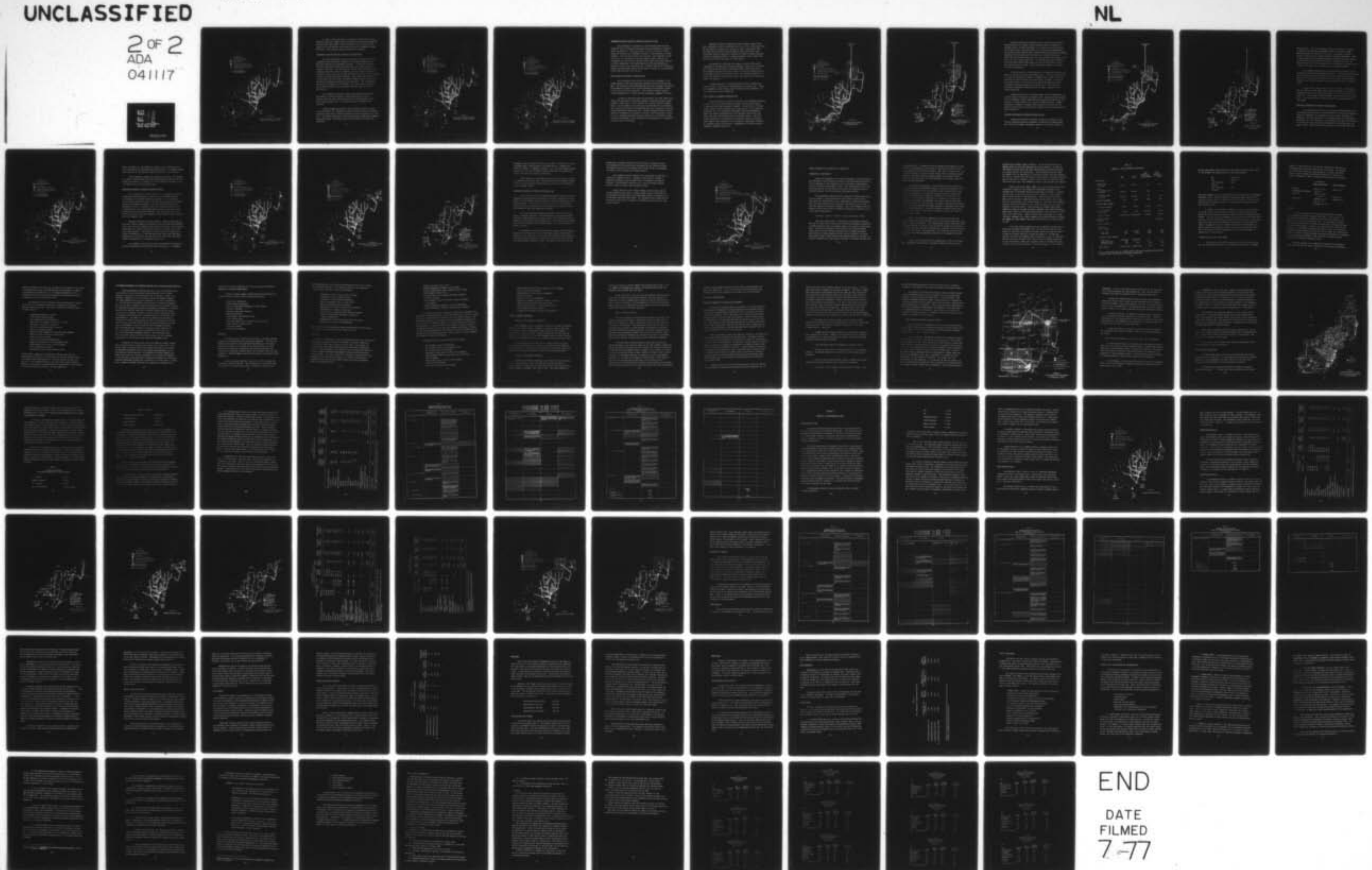

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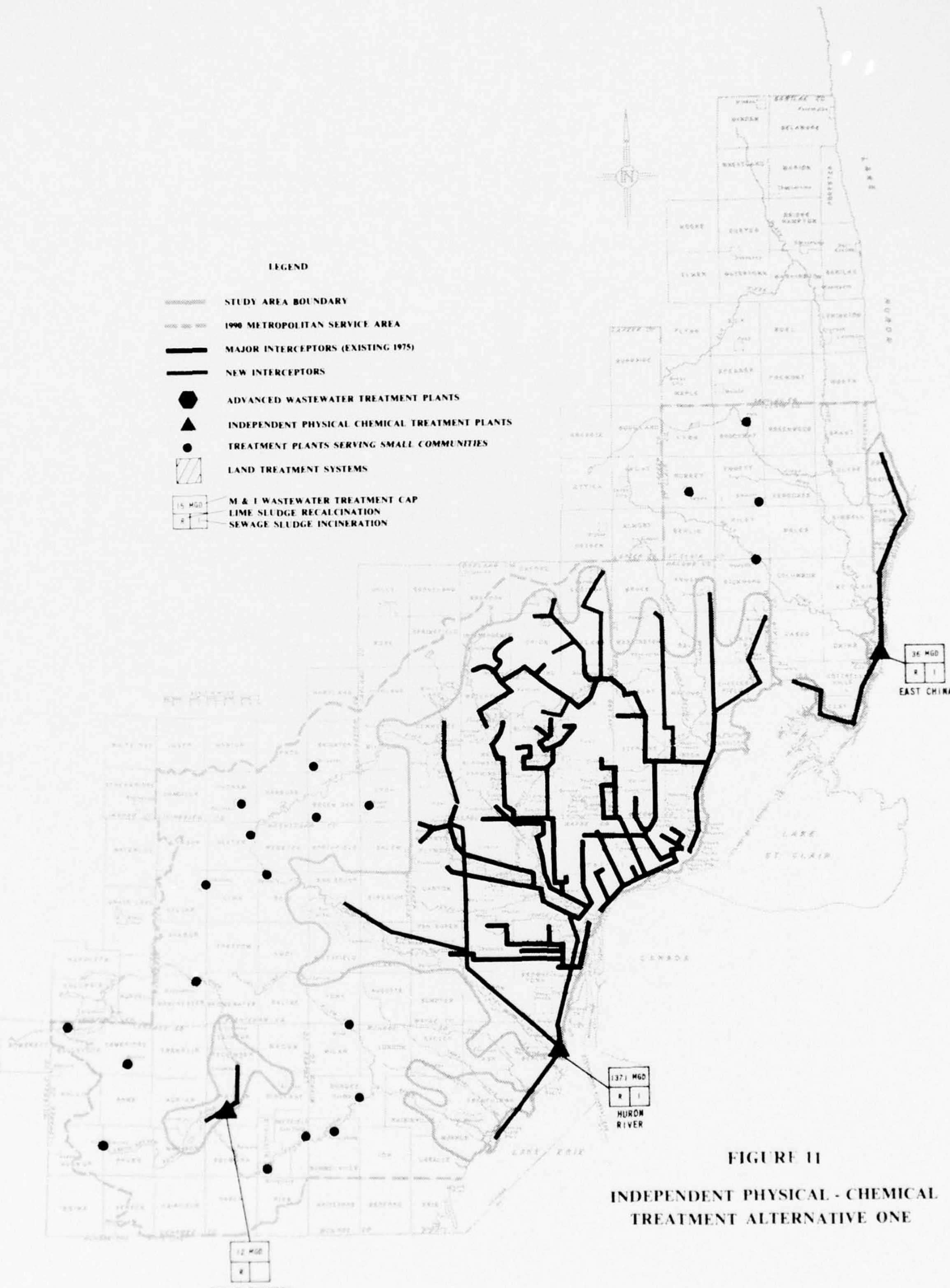

FIGURE 11

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE ONE

In order to keep land use to a minimum and reduce hauling costs, wastewater treatment sludges would be incinerated; ash would be landfilled and recalcined lime reused. A major additional source of waste solids would be the solid material which would accumulate in stormwater storage facilities. That material would be disposed of by landfill.

Independent Physical-Chemical Treatment Alternative Two

Like IPCT Alternative One, this alternative proposes the use of independent physical-chemical treatment as the primary method of both municipal-industrial and stormwater treatment. Unlike IPCT Alternative One, this alternative attempts to maximize the use of major existing treatment facilities in the regional IPCT system. These existing plants, located at Port Huron, Detroit, Wyandotte, and Monroe would involve the conversion of many facilities to IPCT processes in a phased type construction in order to maintain wastewater treatment. Three additional IPCT plants at East China, the Huron River, and Adrian-Tecumseh, would be constructed and would be completely equipped with new facilities. The interception system for this alternative is identical to the one previously presented for the AWT alternative, since the plant locations would be the same. See Figure 12.

The stormwater collection, storage, and treatment system would be identical to the one described in AWT Alternative One with the exception that the three collocated facilities, mentioned above, would vary slightly because the M & I wastewater would be treated by IPCT processes.

Sludge treatment and disposal methods would be similar to those in AWT Alternative Two. Wastewater treatment sludges would be incinerated; recalcined lime would be reused; and waste ash would be disposed of by landfill. The largest quantities of waste solids would be taken from stormwater storage facilities. The storm solids would be allowed to dry and then landfilled.

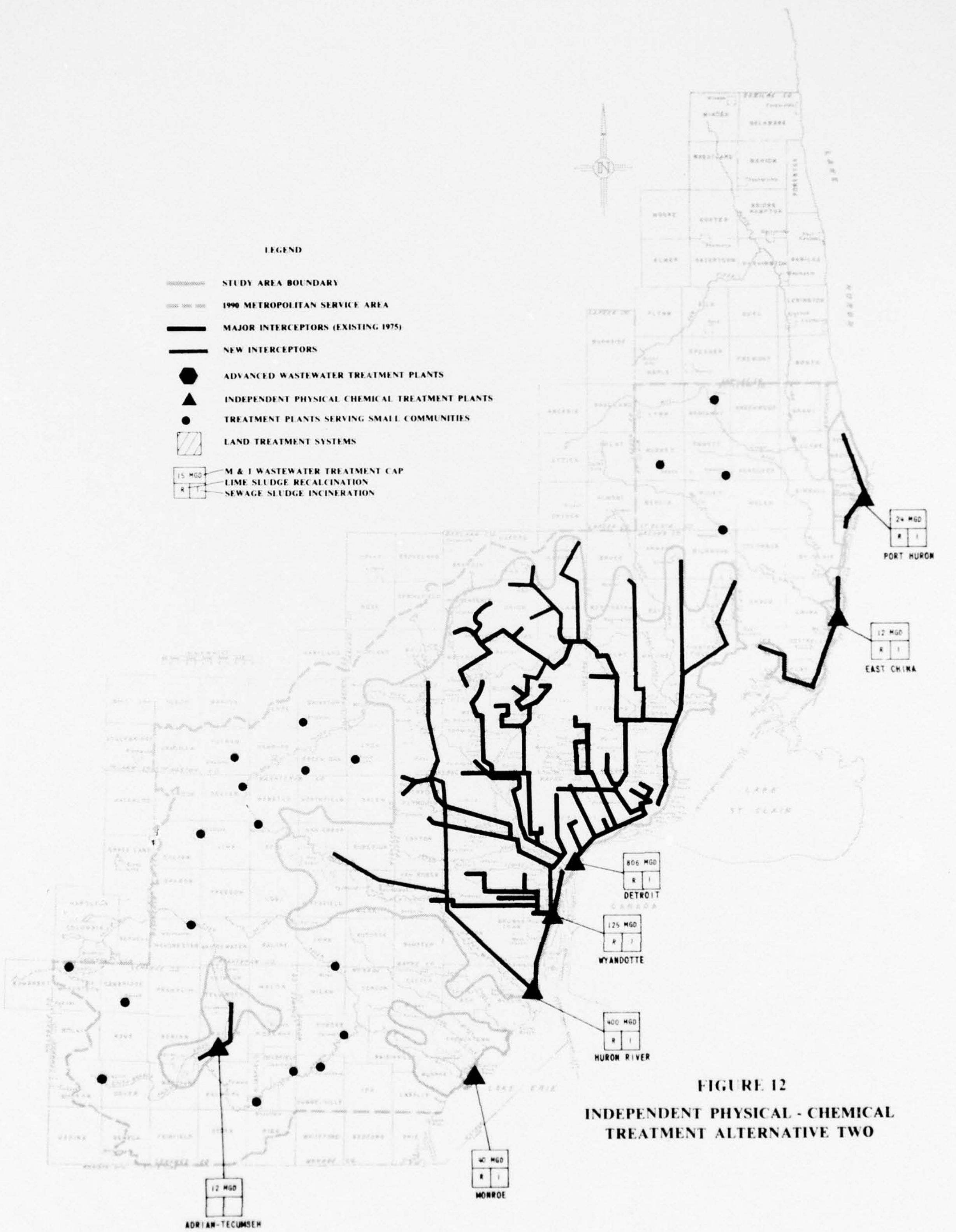

FIGURE 12

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE TWO

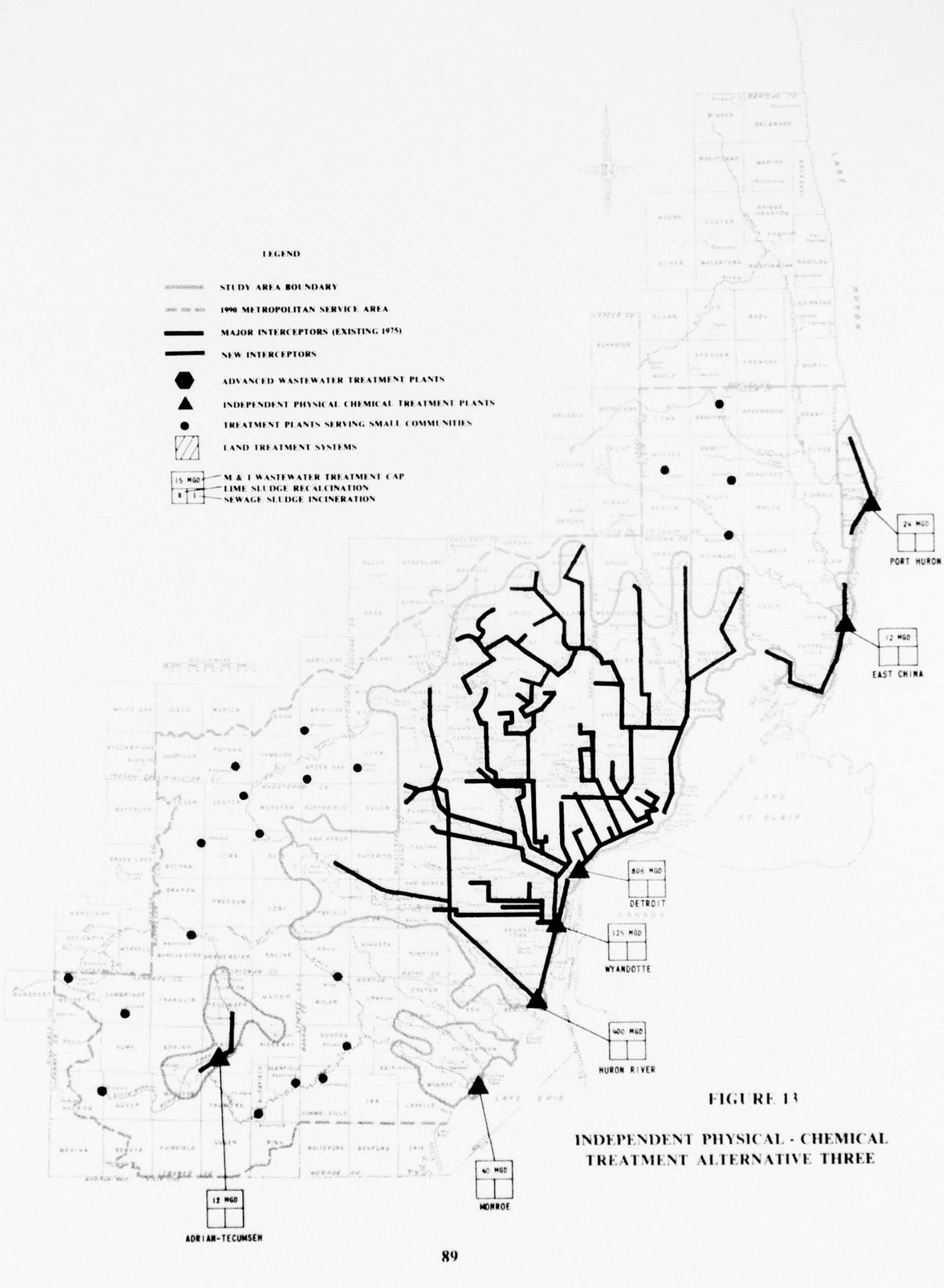

FIGURE 13

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE THREE

Independent Physical-Chemical Treatment Alternative Three

This alternative is identical to IPCT Alternative Two with the exception that no incineration processes would be employed for sludge disposal, see Figure 13. This would result in a large increase in sludge volume for disposal and a subsequent increase in land required for sludge disposal. Also lime reuse would not be possible. The advantages, gained at the cost of the additional land and chemical demand, would be the elimination of a potential air emission source and a significant reduction in energy consumption. The sludge handling and disposal methods are similar to those in AWT Alternative One; therefore, many of the differences between IPCT Alternatives Three and Two would be similar to the differences between AWT Alternatives One and Two.

Land Irrigation Treatment Alternative One

This alternative would utilize land irrigation treatment as the primary method of municipal-industrial wastewater and storm runoff treatment. The alternative would make maximum use of the recyclable constituents of wastewater by applying both treated wastewater and wastewater sludges to land for agricultural production. This alternative would, however, require abandonment of all major existing wastewater treatment facilities.

A mixture of municipal-industrial wastewater and storm runoff would receive the equivalent of secondary treatment at two major aerated lagoon systems in Monroe and St. Clair Counties and a smaller system in Lenawee County. At the lagoon sites, storage would be provided for all wastewater for a period of 155 days, since wastewater would not be applied to the land during winter months and wet periods. Treated wastewater would be chlorinated for disinfection and applied to the land. After percolation through the soil, renovated wastewater would be collected in an underdrain system and either discharged to local streams for flow augmentation or transported to major rivers for discharge.

Wastewater would be transported to the treatment lagoons from a major transmission tunnel paralleling the Lake St. Clair, the Detroit River, and the Lake Erie shoreline, see Figure 14. Major interceptors, from Ann Arbor along the Huron River and from the Huron River north along Hannan Road, would be required to complete the Detroit regional municipal-industrial interceptor system. A second interceptor system, paralleling the St. Clair River, would serve St. Clair County.

The system for collection and storage of storm runoff would be independent of the municipal-industrial wastewater system until the stormwater system would discharge to the Detroit River transmission tunnel. The stormwater storage system would consist of forty-nine community reservoirs ranging from 80 to 690 acres in size. Two regional reservoirs of 3,120 acres would be located at each end of the Detroit River transmission tunnel, see Figure 15.

Sludges generated at the aerated lagoons would be dredged from settling lagoons and applied to land adjacent to the lagoon site. Sludge from stormwater storage lagoons would be removed dry and landfilled, as this method would be most economical.

Land Irrigation Treatment Alternative Two

This alternative is similar to the other land treatment alternative in that it would use land irrigation treatment as the primary method of municipal-industrial wastewater treatment. The majority of the storm runoff, however, would be treated by the IPCT process. This alternative would make use of the recyclable constituents from those wastewaters having the greatest concentrations of the desirable constituents, and would treat less concentrated wastes in wastewater plants. Less land would be required for irrigation and the variable nature of stormwater flows would be less significant in the planning of wastewater irrigation. The alternative would still result in abandonment of the major existing wastewater treatment facilities.

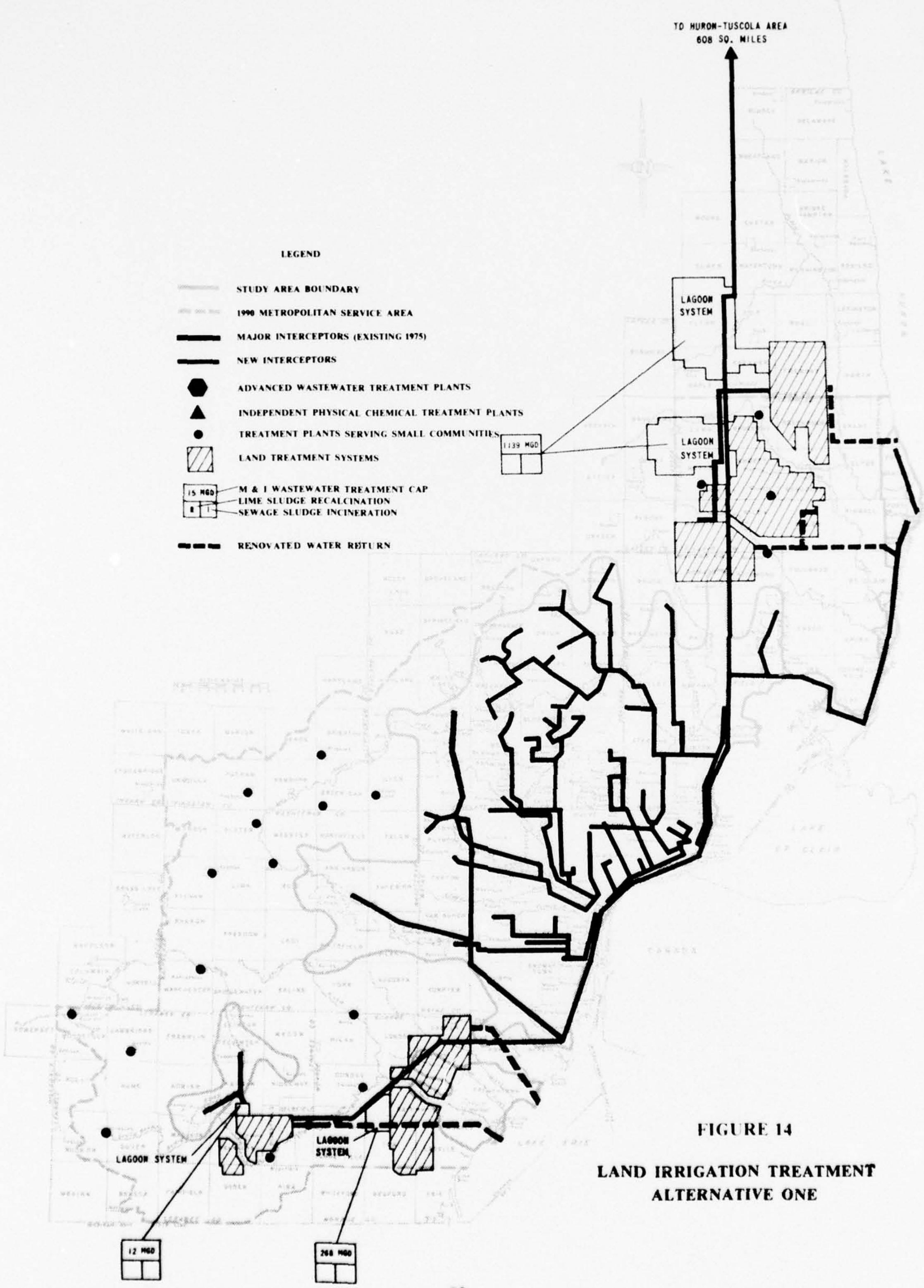

FIGURE 14

LAND IRRIGATION TREATMENT ALTERNATIVE ONE

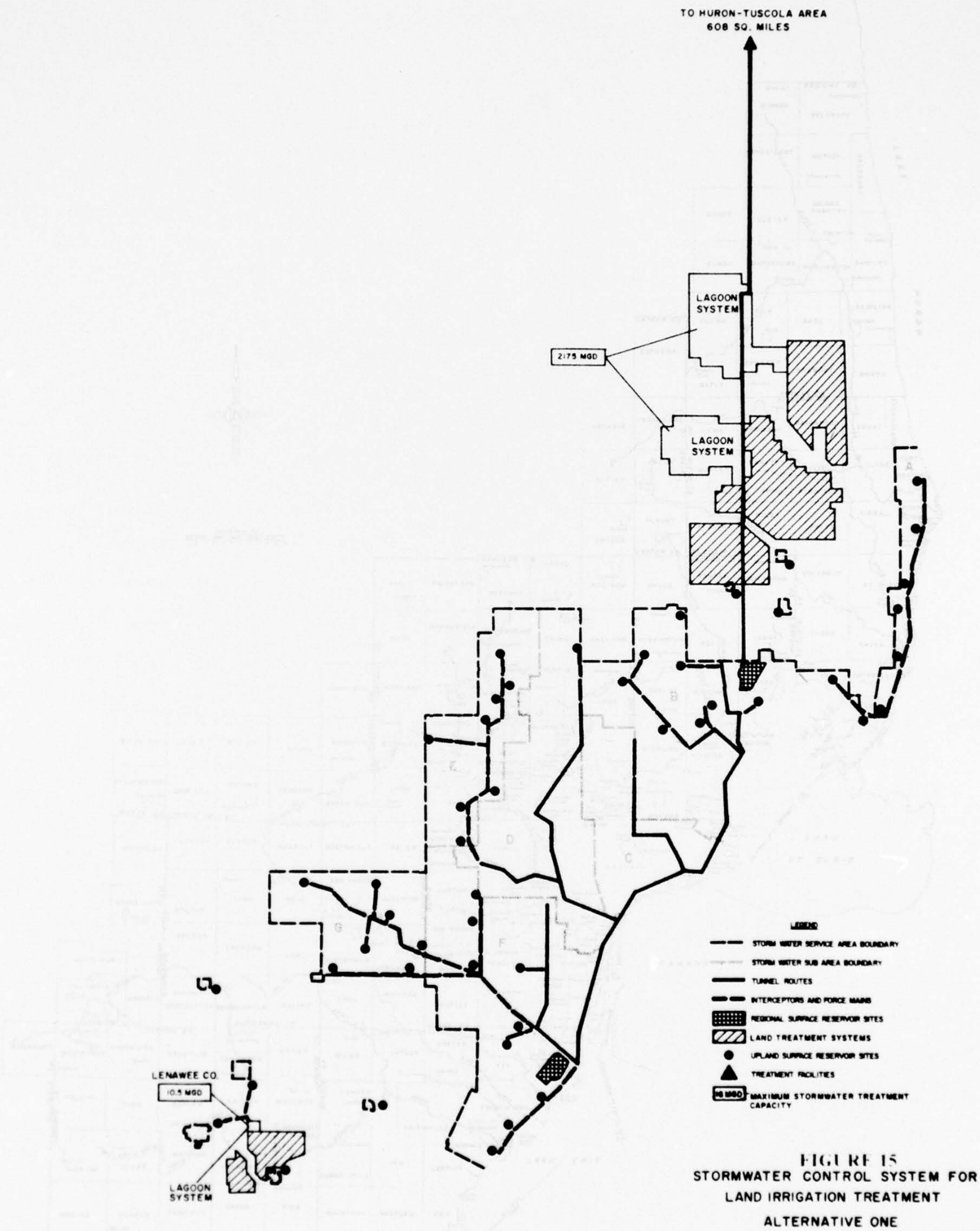

FIGURE 15
STORMWATER CONTROL SYSTEM FOR
LAND IRRIGATION TREATMENT
ALTERNATIVE ONE

Municipal-industrial wastewater would be handled as indicated in Land Alternative One; however, since stormwater would be treated in a separate system, the land requirements for treatment and storage lagoons and irrigation are significantly less. The collection and transmission system would change somewhat since storm and municipal-industrial wastewater separation would be maintained, see Figure 16. A major transmission tunnel would be required from the site of the existing Detroit plant, north to the St. Clair County lagoon site. The northern portion of the Hannan Road interceptor system would remain as a part of the Detroit, rather than the Huron River, system. Other interceptors would be as indicated in earlier alternatives.

The storm runoff in this system would be handled at four major IPCT plants as well as two of the land treatment sites. The four plants would be located at Chesterfield Township in Macomb County, Plymouth, south of Ypsilanti and near the mouth of the Huron River, as shown in Figure 17. Storm water from St. Clair County and the Adrian-Tecumseh areas would be handled on adjacent lagoon and irrigation sites. The collection, storage and transmission system would be the same as employed in the other alternatives.

Sludges generated at the aerated lagoons would be dredged from the settling lagoons and applied to adjacent lands. Solids which would accumulate in stormwater storage lagoons would be removed periodically and disposed of in landfill areas in St. Clair and Lenawee Counties. Sludges generated at stormwater treatment plants would be recalcined and lime reused in the process; the ash would be landfilled with solids from stormwater reservoirs.

Combination Wastewater Treatment Alternative One

Combination wastewater treatment alternatives attempt to create the most favorable wastewater management alternatives by combining the most effective wastewater management components for various portions of

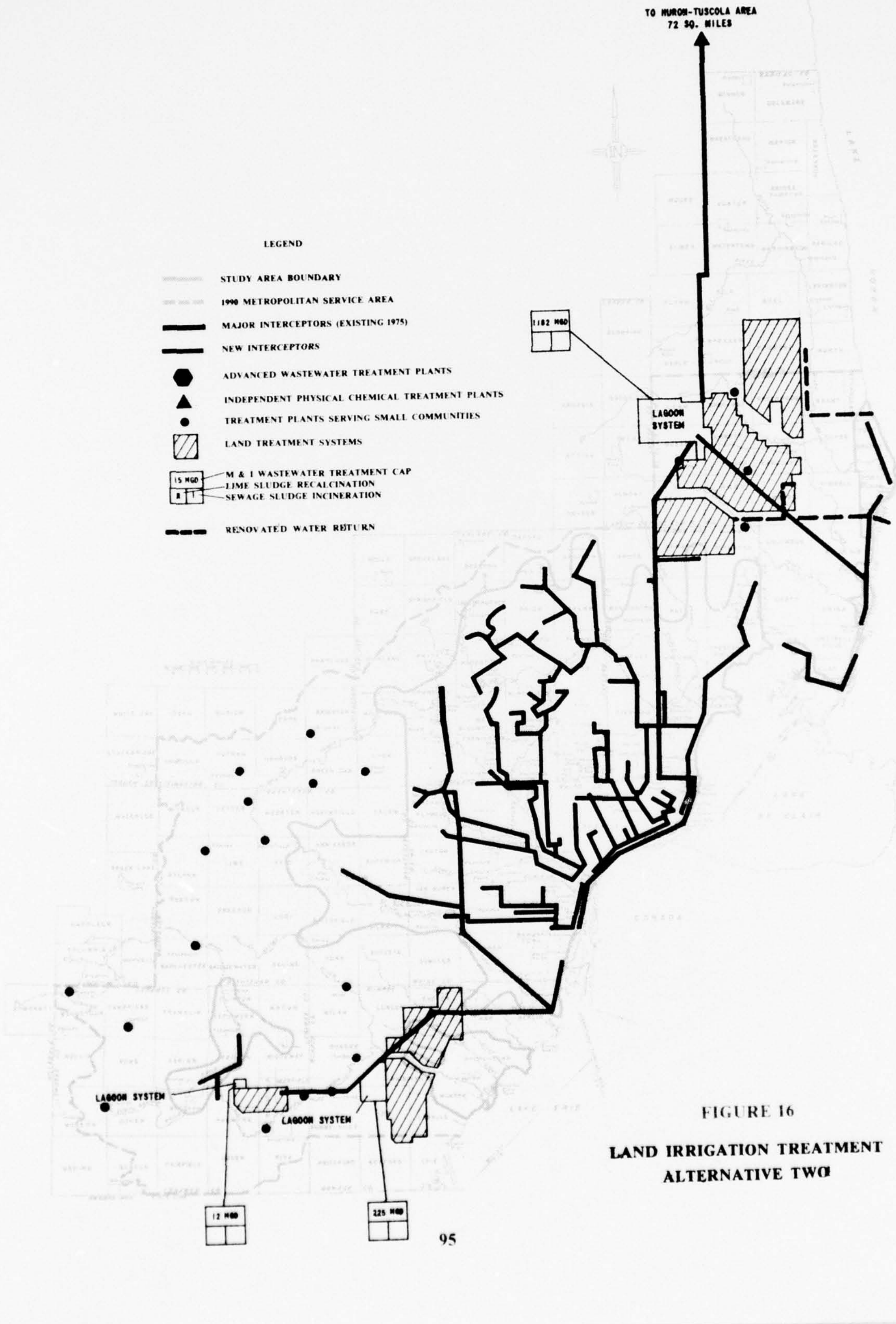

FIGURE 16

LAND IRRIGATION TREATMENT ALTERNATIVE TWO

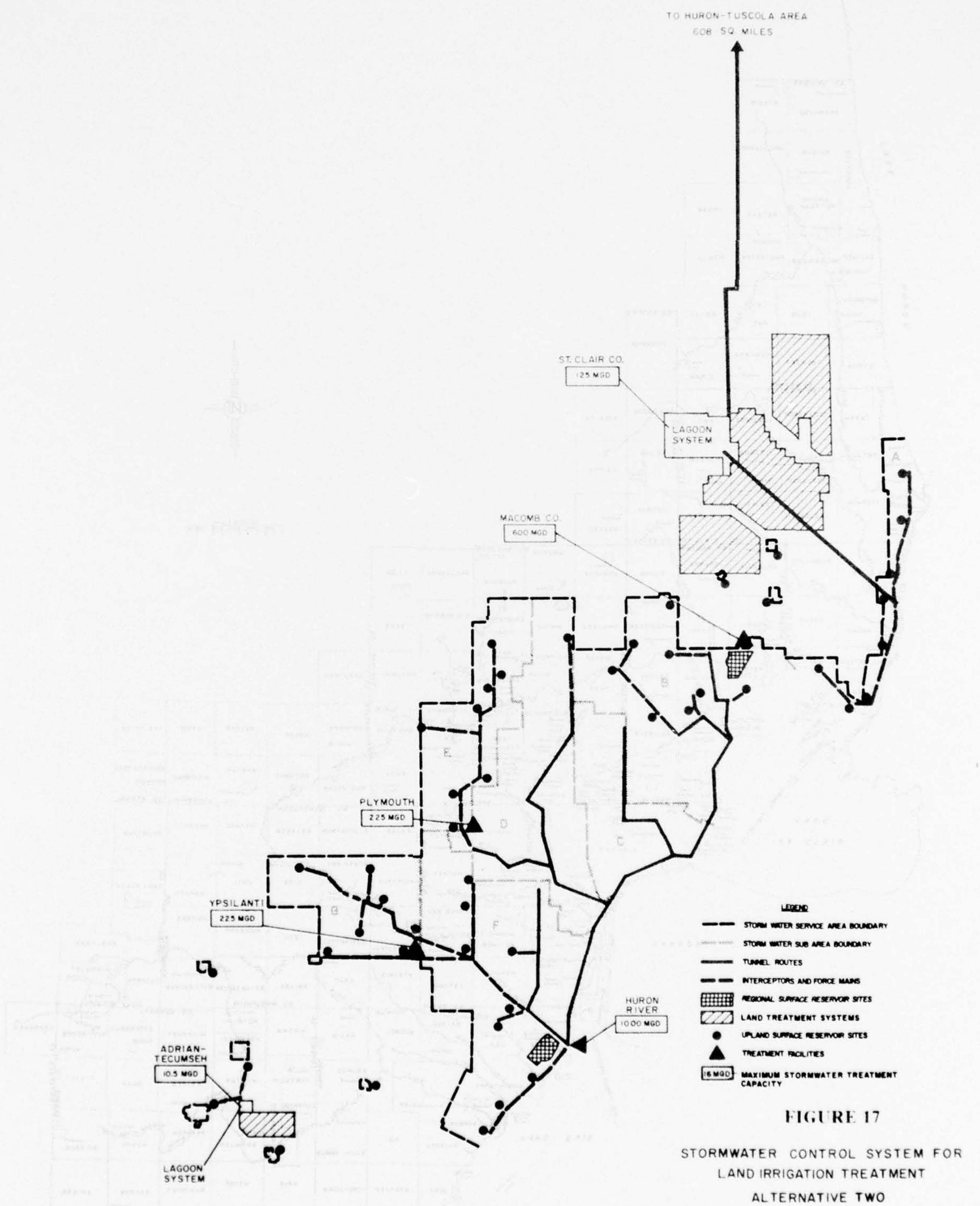

FIGURE 17

STORMWATER CONTROL SYSTEM FOR LAND IRRIGATION TREATMENT ALTERNATIVE TWO

the study area. The first combination alternative proposes conversion to AWT facilities at existing treatment plants, and the use of IPCT facilities where new plants are to be built. Six plants, as shown in Figure 18, would be used to treat municipal-industrial wastewater. Three of these plants would be advanced wastewater treatment facilities created by up-grading existing plants at Port Huron, Detroit and Monroe. The remaining three would be new independent physical-chemical treatment plants constructed at East China, the Huron River, and Adrian-Tecumseh.

The stormwater control system would be similar to the one used in the AWT and IPCT alternatives mentioned earlier. It would include a massive system of interceptor sewers and tunnels, storage facilities and treatment at three collocated facilities (East China, Huron River, and Adrian-Tecumseh), and three new separate sites (Plymouth, Ypsilanti, and Macomb County).

Sludge handling methods vary from plant to plant. Sewage sludges from the Detroit and Port Huron plants would be dewatered and landfilled. Comparable sludges at the Monroe plant would be incinerated and the ash landfilled. Lime sludges at Adrian-Tecumseh and Port Huron would be landfilled. Lime sludges from all other plants would be recalcined and the lime reused.

Combination Wastewater Treatment Alternative Two

This alternative would also utilize both advanced wastewater and independent physical-chemical treatment methods for renovation of municipal-industrial wastewater and independent physical-chemical treatment for stormwater. With one exception, this alternative duplicates Combination Alternative One. The exception is that wastewater from the area just south of the Detroit service area would be handled at the Wyandotte plant (upgraded to AWT), rather than being conveyed down river to the Huron River

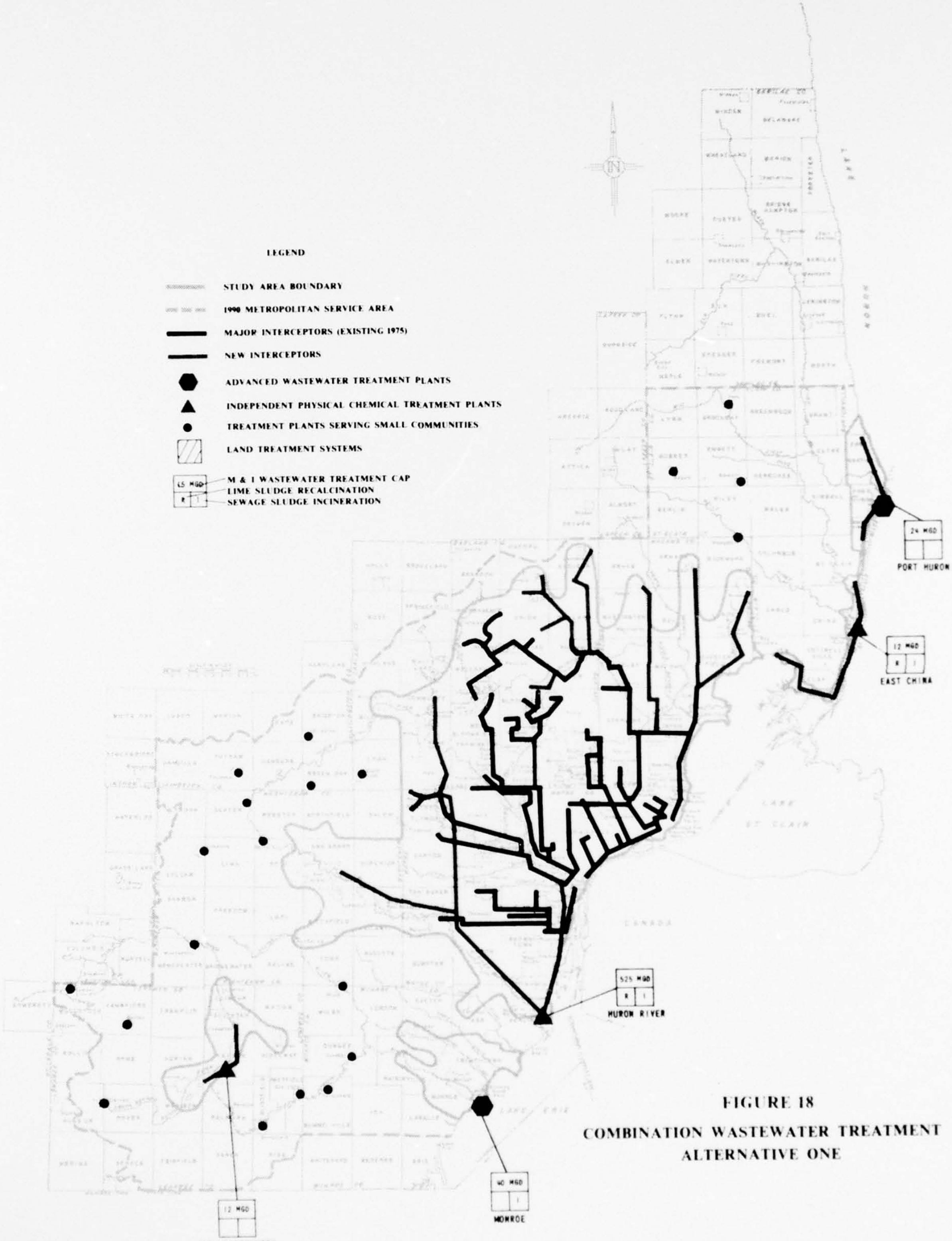

FIGURE 18

COMBINATION WASTEWATER TREATMENT ALTERNATIVE ONE

plant, see Figure 19. The purpose of creating this alternative was to test the viability of maintaining the Wyandotte plant in a regional scheme and to make use of the existing treatment facilities at this location.

Major differences between the alternatives would be: (1) location of a plant at Wyandotte employing both sewage sludge incineration and lime sludge recalcination, (2) reduced size of the downriver interceptor, and (3) reduced size of the Huron River plant.

Combination Wastewater Treatment Alternative Three

This alternative as shown in Figure 20, uses advanced wastewater, independent physical-chemical, and land irrigation treatment methods for renovation of municipal-industrial wastewater. This alternative also uses both independent physical-chemical and land irrigation treatment methods for stormwater renovation. This plan duplicates Combination Alternative Two with the exception that land irrigation treatment would be employed in St. Clair and Lenawee Counties rather than building IPCT plants at East China and Adrian-Tecumseh. This alternative would allow evaluation of land irrigation treatment for less urbanized areas reasonably close to irrigation sites.

Municipal-industrial wastewater would be treated at AWT plants at Port Huron, Detroit, Wyandotte and Monroe, at an IPCT plant near the Huron River, and at the two irrigation sites referred to earlier. The irrigation system would be a totally controlled system; thus, purchase of the land was assumed necessary. The interceptor system would be as described in earlier alternatives (i.e., AWT Alternative One) except that additional transmission lines would be required from the St. Clair River and Adrian-Tecumseh interceptors to the treatment lagoon sites.

The stormwater collection and storage system would be the same as for other alternatives described previously, see Figure 21. Stormwater

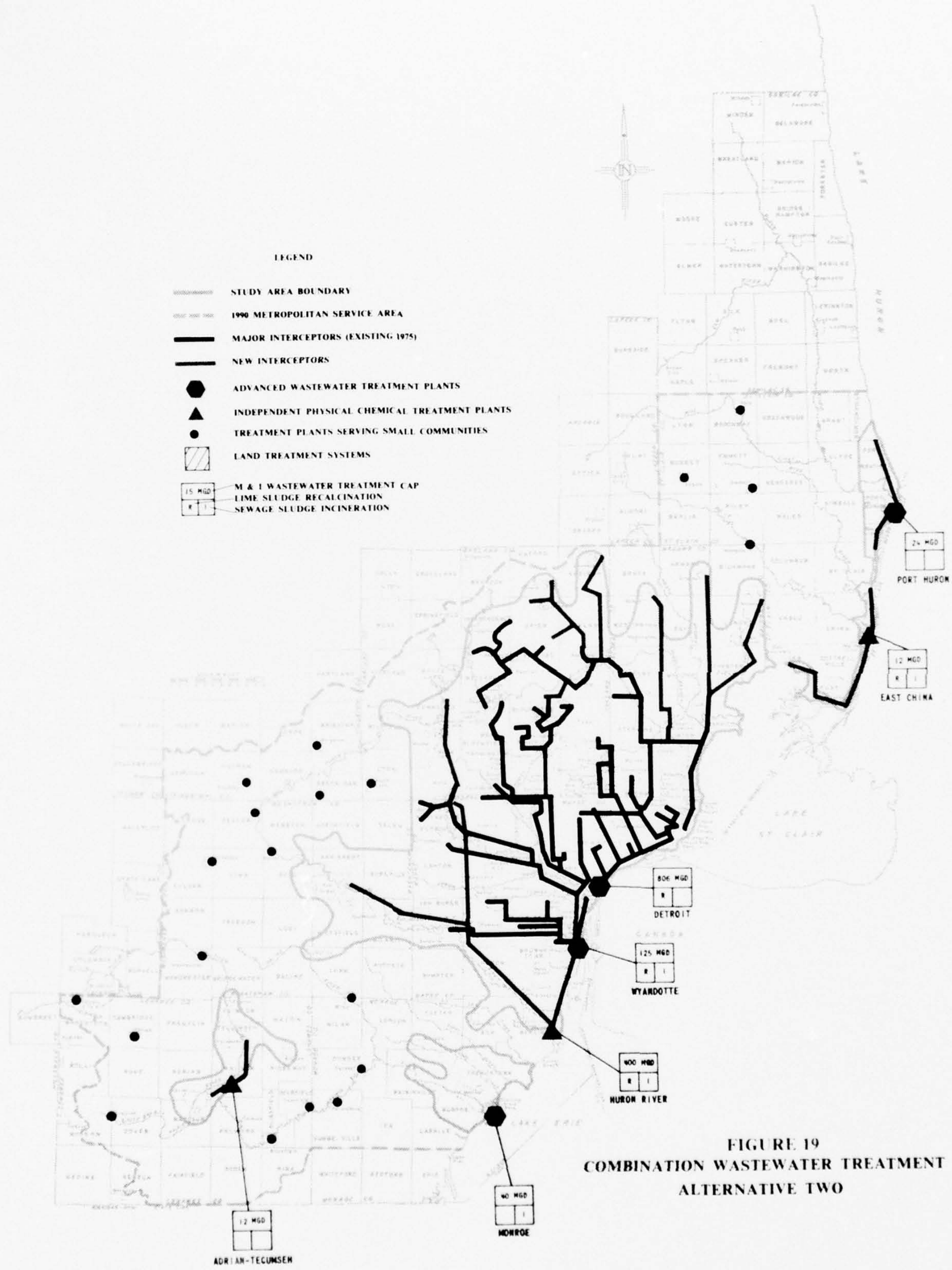

FIGURE 19
COMBINATION WASTEWATER TREATMENT
ALTERNATIVE TWO

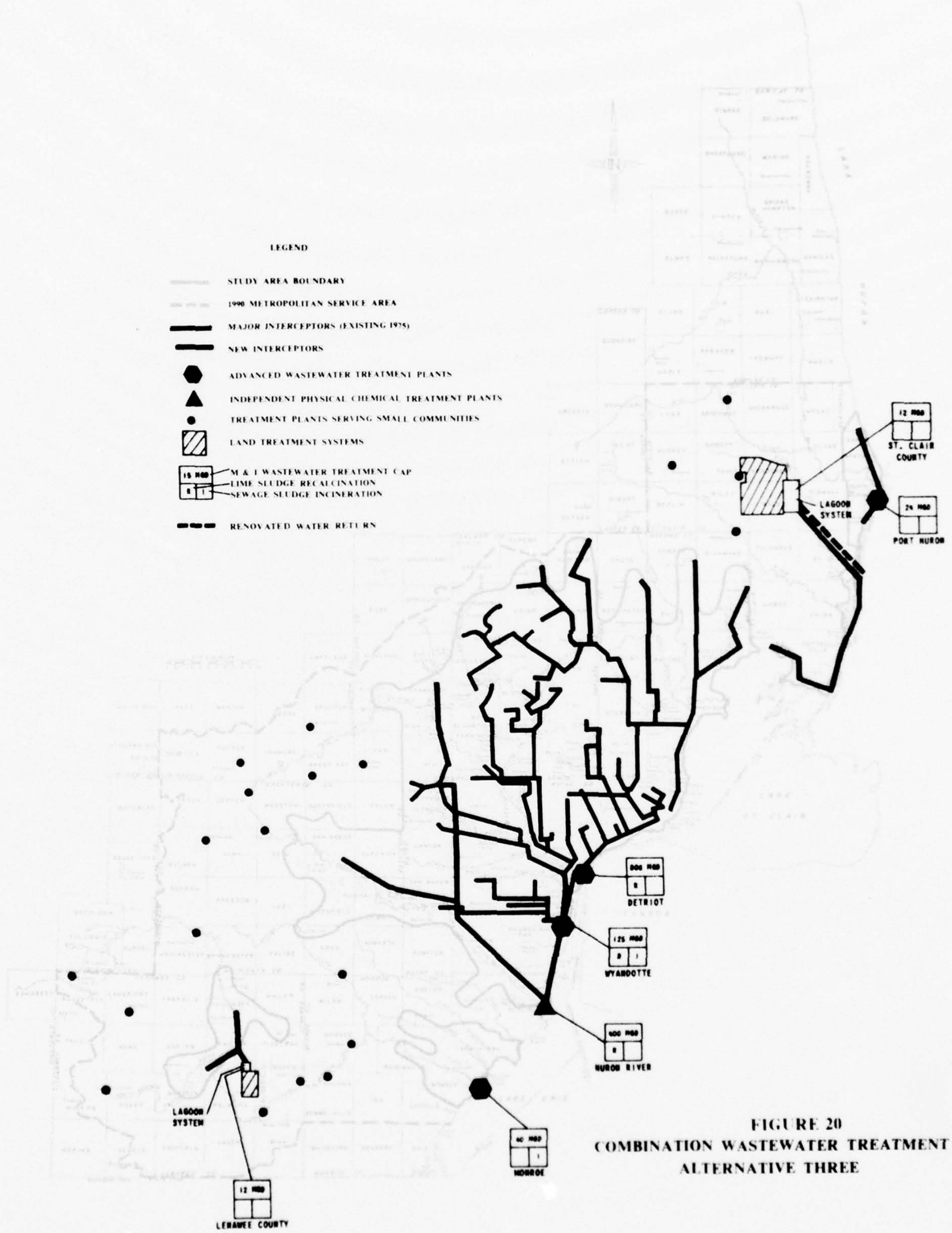

FIGURE 20
COMBINATION WASTEWATER TREATMENT
ALTERNATIVE THREE

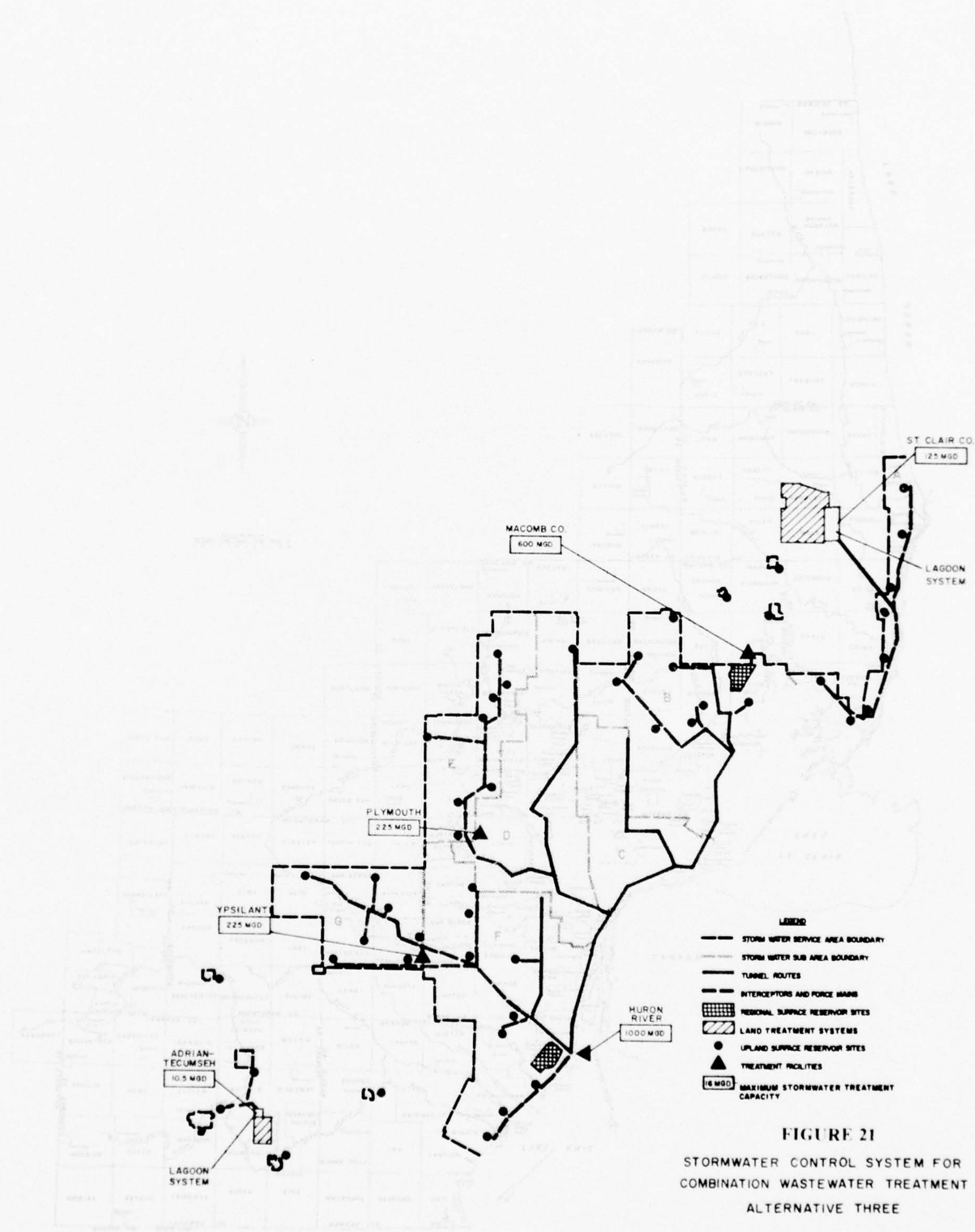

FIGURE 21

STORMWATER CONTROL SYSTEM FOR COMBINATION WASTEWATER TREATMENT ALTERNATIVE THREE

treatment would be provided at IPCT plants located in Chesterfield Township in Macomb County, near the mouth of the Huron River, in Plymouth and south of Ypsilanti. Stormwater collected in St. Clair and Lenawee Counties would flow to the land irrigation systems through the same transmission lines as the municipal-industrial wastewater.

Sludge handling at treatment plants would be the same as described in Combination Alternative Two. Sludge removed from the treatment lagoons in the two land irrigation systems would be applied to the land adjacent to the treatment lagoons.

Combination Wastewater Treatment Alternative Four

This alternative would use advanced wastewater and land irrigation treatment methods for municipal-industrial wastewater renovation and independent physical-chemical and land irrigation treatment methods for stormwater treatment. In this plan, as shown in Figure 22, land irrigation treatment would be utilized in lieu of building any new regional plants for treatment of municipal-industrial wastewater.

Municipal-industrial wastewater treatment plants in Port Huron, Detroit, Wyandotte and Monroe would be maintained and upgraded with AWT processes to make maximum use of existing facilities and minimize loss of treatment effectiveness during implementation. The remainder of the wastewater would be handled at land systems located in St. Clair, Monroe and Lenawee Counties.

Some changes in the regional interceptor system would be required. Wastewater would arrive at the St. Clair County lagoon system through a transmission line from the St. Clair area with wastewater from southern St. Clair County and a transmission line which would intercept the flow from the Oakland-Macomb interceptor system. Flow from the north half of the

Hannan Road interceptor would flow into the Detroit interceptor system. The wastewater from the Huron River interceptor and the downriver Detroit interceptors would flow to the Monroe County lagoon system for subsequent irrigation on land in Monroe and Lenawee Counties.

The stormwater would be handled in the same manner as described in Combination Alternative Three. Stormwater plants would be located in Chesterfield Township, near the Huron River, in Plymouth, and south of Ypsilanti. The stormwater collected in St. Clair and Lenawee Counties would be handled in nearby land irrigation systems.

Sludges generated in the lagoon treatment sites would be applied to land adjacent to the lagoons. Sewage sludges would be incinerated at the Wyandotte and Monroe sites; and lime sludges would be recalcined at all but the Monroe and Port Huron plants. The remainder of the sludges and the stormwater solids would be disposed of at landfill sites in St. Clair and Lenawee Counties.

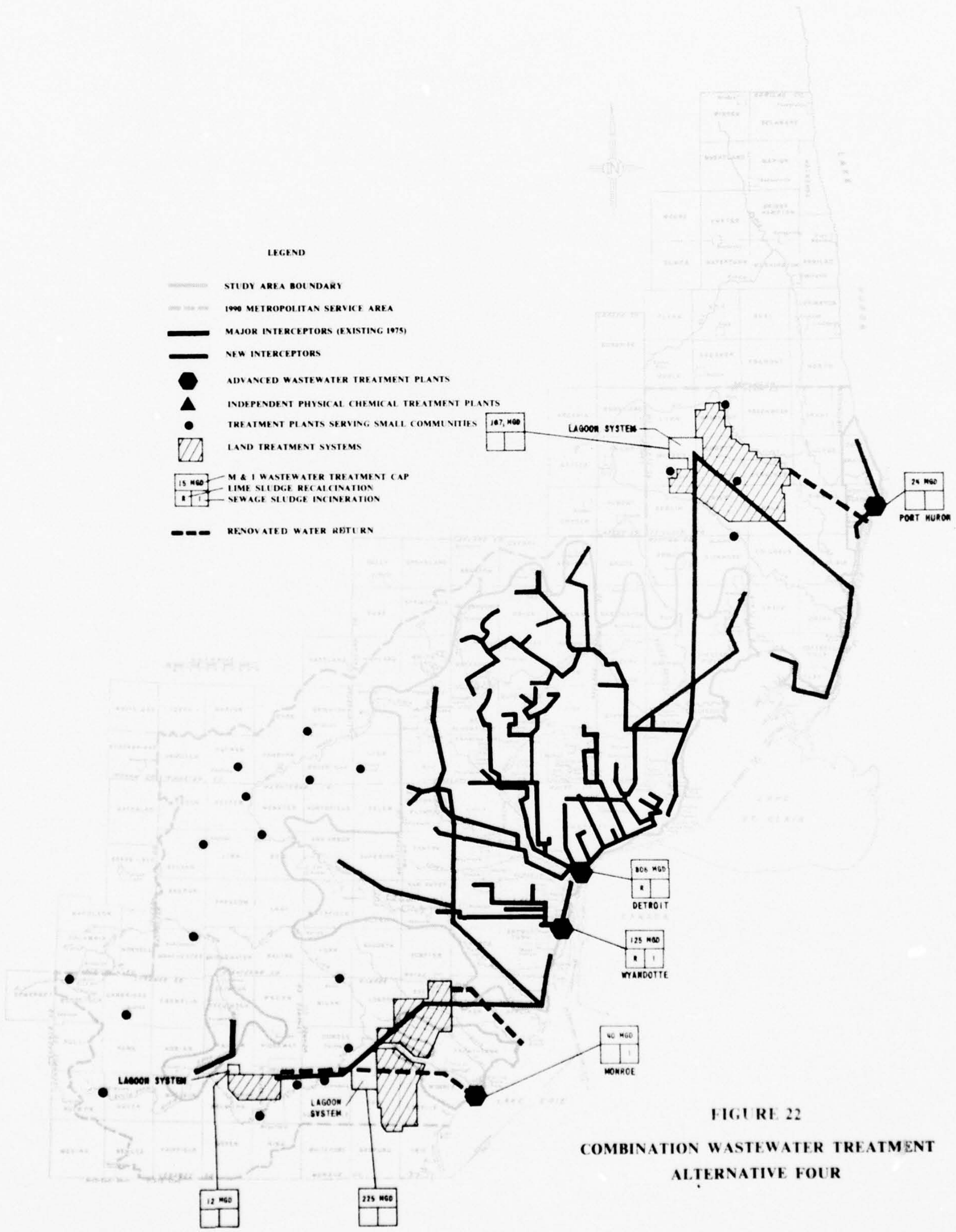

FIGURE 22

COMBINATION WASTEWATER TREATMENT ALTERNATIVE FOUR

IMPACT ASSESSMENT AND EVALUATION OF ALTERNATIVES

Evaluation of Alternatives

During the formation of the eleven alternatives, three alternatives, each employing a single method of treatment, were developed and presented to the evaluators so that evaluation could be carried on simultaneously with the alternative development process. This procedure was used to conserve time and also to facilitate incorporation of information from the evaluation process into the alternative development process.

The information received from the evaluation of these three plans was also useful in identifying both the major impacts which would be associated with implementation of any comprehensive wastewater management plan, and those impacts which would result from extensive use of each of the three methods of wastewater treatment. Thus, the information from the impacts of these three plans was expanded to determine the impact of each of the eleven alternatives.

Ecological, Hygienic, Aesthetic, Social and Economic Effects

Since the primary goals in implementing any wastewater treatment plan are to protect public health and to prevent environmental degradation, a proposed plan must first be evaluated based on its ability to meet those goals. Disinfection procedures used in each of the treatment methods should yield a treated effluent relatively free of harmful pathogens. Other routes of disease transmission must also be considered. Aerosols from aeration tanks in AWT plants and the aerated lagoons in the land irrigation treatment may spread harmful pathogens considerable distances from

the treatment site. Pathogens may also be spread through domestic or game animals and waterfowl which gain access to untreated or partially disinfected wastewater and wastewater sludges. Some areas of concern are: open storage facilities in the storm runoff storage system, wastewater storage lagoons in the land irrigation treatment system, open channels used to distribute only partially disinfected wastewater to irrigation sites, and sludge disposal operations.

A significant improvement in water quality should be realized in streams and rivers in southeastern Michigan. Although the present load of pollutants into Lake Erie would be reduced through implementation of any of these alternatives, this reduction by itself would not significantly improve the eutrophication conditions in Lake Erie. For any major improvements to be realized in Lake Erie it is essential to reduce inputs, including those sources not addressed in the Study, from all watersheds bordering the Lake, not just Michigan. In addition, the existing pollutants in the lake and lake bottom will govern any short or immediate term changes in the eutrophication rate. The land irrigation system was identified as having a higher potential for reducing phosphorus loading than either the AWT or IPCT processes.

Water quality should be improved to the point that total body contact recreation would be allowed in most of the inland streams and rivers, Lake St. Clair, and Lake Erie. The improved water quality should also allow intolerant game fish to survive in the rivers and streams and in Lake Erie if similar wastewater management programs were implemented in other portions of the Lake Erie basin. Any improvement in the Lake Erie fisheries would then depend upon improved management practices in the commercial fishing industry.

A major concern associated with implementation of any of the wastewater management plans would be the excessive demands placed on the con-

struction and equipment supply industries. As can be seen from Table 9, capital costs for the plans range from $4 to $10.5 billion. To meet the 1985 goals of Public Law 92-500, more than $400 million would be expected to be spent annually for construction. Local labor pools would not meet the demand; thus, an immigration of construction workers would be necessary. With similar programs from other areas placing demands on equipment suppliers, meeting construction schedules would be difficult and the additional labor force would also place local demands on housing, utilities and city services.

Another significant impact common to all of the plans would be that residential, commercial, and industrial establishments located on the proposed sites of wastewater facilities would have to relocate. A feeling for the impact of each plan can be gained by referring to the figures in Table 9 which pertain to Land Acquisition. Additional land for treatment plants would have to come from developed urban lands in those cases where an existing plant would require expansion. New plants and stormwater storage sites would be located in less urbanized areas and sites could be selected to minimize impacts. Land required for treatment and storage lagoons in either of the Land Irrigation Treatment Plans would be marginal agricultural land but would require displacement of all residents on 93,000 acres (145 square miles). Impacts would be most significant in the Land Irrigation Treatment Plan (Public Ownership) which would displace residents and commercial establishments from over 700,000 acres (1,100 square miles) of land.

Energy and resource demands are also an important consideration in developing a wastewater management plan. As can be seen from the table below, the IPCT plan would require the least electrical energy but would consume the greatest quantities of fuel and chemicals. The AWT plan requires more power and somewhat smaller quantities of fuel and chemicals. The Land Irrigation Treatment Plans, while requiring minimum quantities of fuel and chemicals (some plant nutrients found in wastewater would be recycled) require large quantities of electrical energy. If all chemical

TABLE 10

SUMMARY OF SINGLE TREATMENT ALTERNATIVES

	AWT	IPCT	LAND (Emphasize Application)	LAND (Emphasize Crops)
SYSTEM COSTS				
Capital Cost $ billion	4.2-4.3	4.0-4.3	6.0	10.1
Annual Op. & Maint. Cost $ million	110-120	105-120	155	294
Toal Annual Cost $ million	370-375	345-375	525	890
OPERATING MANPOWER	3750	2350	1800	2815
PURCHASED LAND (ACRES)				
Stormwater System	23,500	23,500	23,500	23,500
Waste Treatment Facilities	1,400	900	670,000	73,000
Sludge Disposal	3,200-10,500	3,500-15,800	43,500	43,500
PRIVATELY-OWNED FARMLAND	---	---	---	1,616,400
RESOURCE DEMANDS				
Electrical Power Demand				
Avg. (MGD)	320	150-200	1142	660
Peak (MW)	2200	2050	4100	2900
Chemicals (Daily Demand)				
Lime (T/D)	1500-1700	1500-2800	---	---
Methoanol (T/D)	200	---	---	---
Chlorine (T/D)	200	900	180	180
Fuel* MM-BTU	4,000-36,000	7,000-31,000	600	600

*Fuel includes diesel fuel for sludge hauling and either natural gas or fuel for activated carbon regeneration and sludge incineration.

and fuel requirements were related to an equivalent electrical power demand (10,000 BTU/KWHR) the demand for each of the plans would be:

AWT	400-530 MW
IPCT	350-420
Land Irrigation (Public)	1142
Land Irrigation (Private)	1100

Peak power demands for all of the plans could be attributed to the stormwater management system. Auxiliary diesel or gas turbine power plants would be required to provide power on short notice for that system. That auxiliary power generation capability would be a valuable standby power source for the metropolitan area.

In summary, Land Irrigation Treatment on publicly owned land does not appear feasible for the entire Southeastern Michigan area due to excessive social and economic disruption, excessive cost and excessive energy demands. The Land Irrigation Treatment plan which would allow private ownership and control of the farming operation, while less socially objectionable, would still require excessive amounts of energy and would have excessive costs. Although both the IPCT and AWT plans have their advantages, the better solution would probably utilize parts of each with possible favorable uses of Land Irrigation Treatment in the less urbanized areas of Lenawee and St. Clair Counties.

COORDINATION AND PUBLIC INVOLVEMENT

The stage one period of the survey scope study was also the time when the ground work was done for the coordination and public involvement

program. It was during this time that the Coordinating Committee was established and its purpose and objectives were defined. The meetings held during this period also helped establish a valuable previewing function which the Committee performed throughout all stages of the study by reviewing the public involvement presentation, as shown below.

	Coordinating Committee Meetings	Public Meetings
Series I	March 23, 1972	April 1972
Environmental Workshops	June 1972	
Series II	June 12 & July 16, 1972	July 1972
Series III	December 8, 1972	December 1972
	May 31, 1973	
	September 27, 1973	

Series I

As stated in Chapter I, the Coordinating Committee included representatives from several agencies and groups. (See list on p. 5). The purpose of this body, as expressed by the District Engineer in his letter of invitation to the agencies, was: "To coordinate the survey scope study effort which will develop alternatives for managing wastewater in Southeastern Michigan." Further, the objectives of the Committee were stated as: (1) To provide prospective alternative plans, (2) To serve as a forum for varying technical and public views to insure full consideration, and (3) To provide insight and review on alternative proposals, as spokesmen for various sectors of Federal, State, Municipal, and public groups, concerned with wastewater management plans.

The first meeting of the Committee was primarily an information meeting: the plan for the survey scope phase of the wastewater management

study was presented, the three pure alternatives were examined in the context of the feasibility study, and study materials were provided. In addition the Committee was informed as to (a) the makeup and expertise of the wastewater study staff, and (b) what appropriate contracts were let with an examination of the work effort of each.

The purpose of the first series of public meetings was to present the results of the feasibility study and to introduce the follow-up, detailed survey scope study. The questions covered the following types of subject matter:

Metropolitan approach to system
County future land use plants
Soil conditions for land treatment
Opportunity for farmers to have a say in plans
Treatment of sludge as solid waste
Who will receive final plans for action
Extent of stormwater runoff
What can be done immediately to resolve some problems
Effect of plans on levels of inland lakes
Control of silt in streams
Conflict or likeness with SEMCOG plan
Amount of land needed for land treatment system
Effectiveness of recycling of land treatment
Date of completion of study
Opportunity for more formal Advisory Group

A formal paper evaluating the Feasibility Study was read into the public meeting in Detroit by a Staff member of the Public Works Division of the Wayne County Road Commission. This was the most critical--pro and con--of any presentation made in all three of the series of public meetings. At the time of the presentation, this paper was a Staff product; it was later officially endorsed by the Road Commission.

Environmental Workshops and Informal Contacts with Citizens and Local Officials

Three environmental workshops were held in June 1972 between Series I and Series II of the Coordinating Committee Meetings and the Public Meetings. The series of three meetings, held in Flat Rock, Detroit, and Rochester, attempted (1) to bring together Corps environmental planners with local people who have an active interest in, or could be influential in, resolving major environmental issues related to wastewater management, and (2) to provide a channel through which the public can strongly influence the formation of wastewater planning and management alternatives. It was the feeling of the District Staff that, by working together with the public, a plan could be developed to satisfy the water quality problems and needs of the area: a plan that would be acceptable socially, politically, and environmentally. The format for each of the meetings was the same and consisted of a review of the feasibility report, presentations of the AWT technical study, the land disposal study, the physical-chemical technical study, the stormwater technical study and the environmental studies. These presentations were followed by discussions and an effort on the part of the Corps Staff to solicit participant's views on ways to resolve the wastewater management problems. These workshops, which draw rather small groups of officials and citizens, did not contribute significantly to the progress of the wastewater management study.

Throughout the entire study, there were numerous informal contacts with citizens and local officials from January 1972 to April 1973. The greater number of the more than thirty meetings came after the release of the Wastewater Management brochure, The Search for Clean Water, and the third series of public meetings. The sessions had various purposes, but a major aim of all was to provide information on the nature and progress of the study and to seek constructive suggestions regarding the alternative wastewater management systems being considered by the Corps Staff. In addition, a number of informal interviews was conducted by a member of the

Corps Staff to obtain information for the institutional arrangements appendix of the survey scope report.

Involved in these informal contact meetings were officials and citizens from the following types of groups and agencies:

County Drain Commissions
County Planning Commission
County and Municipal Departments of Public Works
Municipal Engineers
Municipal Sewer Plant Operators
Newspaper Reporters
State Senators and Representatives
County Commissioners
State and Federal Soils Conservation Service Staffs
County Extension Service Staffs
Farm Bureau members
Land owners and farmers

Series II

The second series of meetings in the public involvement program began with three meetings of the Coordinating committee. The first two meetings were devoted to a more detailed consideration of the various alternative systems to be included in the study; whereas, the third meeting was involved with suggestions and discussion regarding site selection for wastewater treatment plants and included criteria for such selection. Committee members actively participated in this phase of plan formulation.

A series of public meetings, held in July, 1972, followed the coordinating Committee meeting. Their purpose was to outline the first cut approach to the survey scope study, to present to the public the

background material on the four basic alternative systems, and to stimulate community reactions. Some additional questions and suggestions raised at these meetings concerned the following:

- Duplication of Corps work with that of SEMCOG
- Elimination of small treatment plants
- Challenge to high population projections
- Need for stormwater drains in rural areas
- Need for huge Huron River interceptor
- Perspective and design for year 2020 interceptors
- Effectiveness in cleaning up Lake Erie
- Proposal for a 9-member Technical Advisory Committee
- Value of Stanford Watershed Model in regard to maximum urbanization
- Responsibility for building and operating the system
- Relationship to atomic power generators

This second series of meetings was better attended than the April series, but resulted in little in-put for the study as a whole.

Series III

During the third series of public involvement meetings, the Coordinating Committee was brought up to date on consultant contractor studies and the Corps Staff work toward completion of the study. Also brought out at this meeting were eight selected wastewater management alternatives. Seven of these alternatives were formed utilizing the components developed in the six areas of wastewater management technology described earlier in this chapter. The eighth alternative, developed by the Corps utilizing information from the State of Michigan, is a shorter term wastewater management plan design to meet existing State water quality standards. These eight alternatives are:

State of Michigan Criteria Plan

Advanced Wastewater Treatment System (Total)

Physical-Chemical Wastewater Treatment System (Total)

Land Treatment System (Total)

Physical-Chemical and Advanced Wastewater Treatment System (Combined)

Land Treatment System with Physical-Chemical Treatment of Stormwater

Combined Wastewater Treatment System (Extended AWT)

Combined Wastewater Treatment (Extended Land Treatment)

The third series of public meetings occurred during December 1972 and drew the largest attendance in the three part series. The major purpose of this set of hearings was to present some of the study findings of the contractor consultants in regard to the various treatment systems and to elicit reactions of community members to the aforementioned alternatives. At each meeting, in Bad Axe, Monroe, and Richmond, the major concern of the participants was focused on the land treatment alternative. Seemingly, the press announcements for these meetings and the circulation of the brochure outlining the alternatives to date generated the large attendance and interest in these public meetings.

Questions and topics raised included the following:

Land treatment success in Australia

Use of septic tanks in land treatment areas

Use of chlorine as a disinfectant

Saturation of land used as a filter for wastewater

Land treatment effect on ground water and lake levels

Odor of lagoons

Total acquisition of land for land treatment

Costs of each alternative

Necessity for treating all stormwater

Effectiveness of removing toxic metals in land treatment

Size of equalization lagoons

Consideration of institutional arrangements

Disposal of sludge

Basis of Corps soils information

Inclusion of economic and social impacts of system

Effect of polluted alfalfa on taste of milk

Soil's ability to make 2 inches of water a week

How to handle mercury and cyanide

Location of final power to select an alternative

Impacts of Public Involvement

Impact of the Coordinating Committee

This Committee in its six meetings to date has not made a measurable impact on the planning process. Members in one meeting were of some help in developing criteria for treatment plant location and in reviewing suggested sites for such plants. Suggestions were also put forth for the mounting of a pilot project of the land treatment system in order to better evaluate this alternative; to date this suggestion has not been acted upon.

The Committee did serve helpfully as a means by which the Corps kept various agencies abreast of the steps and progress of the wastewater management study. It also had a useful function as a forum to receive and discuss Corps Staff and consultants' reports as the study moved along.

Impact of Environmental Workshops

The three environmental workshops did not make a major contribution to the planning process. The Staff developed three matrix tables to represent three pure wastewater treatment alternatives, each utilizing one specific method of treatment, AWT, IPCT or Land. The Staff attempted to

utilize this chart by inviting comments from workshop participants. Due to a number of considerations, however, the desired objective was not realized, and the charts were laid aside.

On the other hand, it was felt that the workshops were of value to people with technical and scientific knowledge since they provided an opportunity for direct communication between the planning people and the agency people in the field. An environmentalist consultant from Michigan State University, who served with the Corps Staff in two of the workshops, proved most helpful on scientific questions.

Impact of Public Meetings

The first two series of public meetings seemed to have only minor impacts on the planning process. Participants urged the Corps Staff to continue the meetings in order to continue to provide an opportunity for the public to participate. Other participants were strongly critical of the Corps for not working in closer harmony and cooperation with local (township and municipal) planning agencies. A proposal, suggested by one participant and supported by another, for the Corps to establish a nine man Technical Advisory Committee was received by the Corps. The proposal was not acted upon due to the existence of the Coordinating Committee.

The third series of public meetings, especially those held at Bad Axe and Monroe, had a definite impact on the land treatment alternative. Serious questions were raised about the accuracy and soundness of data used to develop the land treatment system in regard to soil composition, ability of soils to accept two inches of water a week for 35 weeks a year, and the necessity for government ownership of farmland utilized for wastewater treatment. As a result of the questions brought forth in these meetings and the resulting questions and meetings in the following months, a completely new alternative method of employing land treatment was developed. This alternative was based on utilization of private farm lands and attempted

to adopt a land treatment system to fit the area's cropping pattern and varied soil conditions. It was felt that this method of employing land treatment would be more appealing to the farmers and local residents.

ADDITIONAL CONSIDERATIONS

Additional Options for Utilizing Land Treatment

The need for developing additional methods for applying land treatment concepts in Southeastern Michigan resulted from considerable public reaction to the information and alternative plans presented in the public participation program. Public opposition to the original land treatment concept was due to the fact that large amounts of private property would be confiscated if a large-scale land treatment system were put into operation. The creation of this system would mean that the current land owner and his family would have to relocate and possibly change occupations, the current cropping patterns of the affected area would be changed, and the existing economy of the area would be altered.

New land treatment options were examined, therefore, that would alleviate these problems by meeting certain objectives. The farmer would be allowed to retain his ownership and residence and control his agricultural activities and cropping patterns. He would also contract with the operating agency to receive a set amount of wastewater on a somewhat flexible schedule. The additional advantages would be: no mass purchase of land would be necessary; there would be no loss of land from local tax rolls because of irrigation land purchase; residents would not be forced to relocate; cropping patterns in the area would not be altered or controlled; local farm suppliers would not be affected; and there would be an increase in agricultural yield.

Toward that end, the District contracted with a group of crop and soil scientists at Michigan State University and Dow Engineering, Inc., to

develop and design land irrigation systems on this new concept. A twenty-five county area was studied for potential irrigation. This area is larger than the previously investigated area because under the new concept wastewater application rates would be reduced and, therefore, more land would be required. The area was limited to these twenty-five counties since it was judged economically unfeasible to build a distribution and return system to serve beyond these boundaries. The land in these areas was divided into treatment zones; lands having similar characteristics and irrigation facilities were grouped in the same zone. Wastewater application rates for a particular zone were based on the amount of water the soil could accept, the ability of the soil and crops to achieve the desired wastewater renovation, the type of crop projected for the area, and the need for drainage.

In designing the irrigation systems, it was necessary to make several design assumptions so that the objectives of the option could be met without disrupting the wastewater renovation capabilities of the land treatment process. They were:

1. Farmers would be allowed freedom in the selection of crops and their rotation for his farm. However, for the purpose of cost estimation and determination of annual wastewater application, the cropping patterns previously presented would be assumed.

2. Each farm would possess an independent irrigation system.

3. Wastewater would have to be applied according to an irrigation schedule. The schedule would not be so restrictive as to hamper farming operations.

4. Within a given irrigation area, nearly all farmers with usable cropland are eventually expected to be recipients of wastewater.

5. Facilities to be included in the design would include: a sys-

tem for distributing wastewater within an irrigation zone, irrigation equipment, a tile drainage system and a collection and discharge system.

Two systems were investigated using the private ownership concept of land irrigation treatment for all wastewater and urban storm runoff generated in the Southeastern Michigan area. In one alternative, Land Irrigation Treatment Alternative Three, aerated lagoons, as described in previously presented land irrigation plans, would be used to achieve secondary treatment prior to irrigation. The second alternative would make use of existing secondary treatment plants for treatment of municipal-industrial wastewater prior to irrigation. Urban runoff would receive the equivalent of primary treatment at stormwater storage sites prior to final storage and irrigation due to settling.

Land Irrigation Treatment Alternative Three

This alternative was designed for use of the revised Land irrigation concept for all municipal-industrial wastewater and urban storm runoff from the area. It allows for comparison with Land Irrigation Treatment Alternative One. This is shown in Figure 23.

The plan would use a wastewater collection and transmission system and a stormwater collection and storage system identical to that designed for Land Alternative One. From the regional storage lagoons in Macomb and Monroe Counties, wastewater would be conveyed to treatment lagoon systems in St. Clair and Monroe Counties. A smaller treatment lagoon system would be located east of Adrian to serve the Adrian-Tecumseh area. From the treatment lagoons, wastewater would be transferred to storage lagoon systems at the treatment lagoon sites, transferred to a storage site near Frankenmuth, or distributed for irrigation. The storage site near Frankenmuth has many advantages. It eliminates the need for aeration lagoons at Frankenmuth and wastewater being transported to Frankenmuth would be secondary effluent rather than raw wastewater. By providing storage at

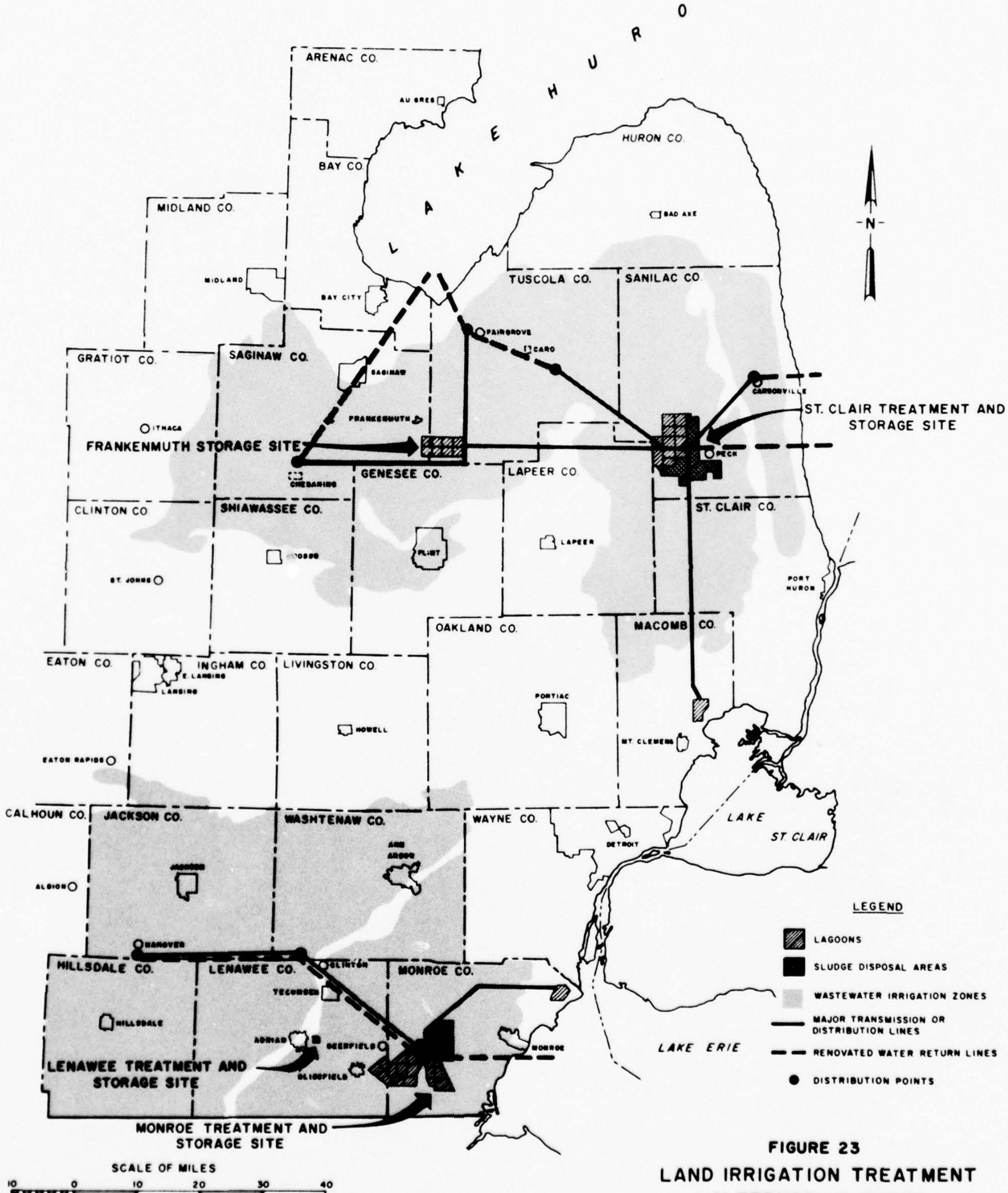

FIGURE 23
LAND IRRIGATION TREATMENT
ALTERNATIVE THREE

Frankenmuth, the cost of the distribution system would be less since much of it could be designed for lower maximum flow. The 1,616,400 acres of irrigation land would be distributed over a twenty-one county area.

Disinfection procedures would be more stringent since wastewater distribution would be over a wider area and exposure would be increased. Following treatment, ozone would be added to kill most of the bacteria and virus. Prior to distribution to the irrigation areas, sufficient chlorine would be added so as to insure a residual through the distribution system.

Following irrigation, the renovated percolate would be collected in a tile drainage system and returned to a collection point. From the collection point, the renovated water could either be added to local rivers and streams for flow augmentation or transferred to a pipeline capable of returning the total flow to a major water body.

Sludges generated at the lagoon treatment sites would be handled, as in previous land irrigation designs, by application to land adjacent to the lagoons.

Land Irrigation Treatment Using Existing Plants for Pre-Treatment

As previously mentioned, an alternative was considered which would make use of the existing secondary treatment plants in southeastern Michigan rather than building aerated lagoons to perform that function. This would make use of existing facilities and eliminate some of the aesthetic disadvantages of large treatment lagoons. It would also facilitate conveyance of treated wastewater to storage areas rather than raw wastewater.

The development of the plan was not carried out beyond a preliminary stage, since it was primarily intended to allow for the evaluation of the feasibility of such a plan.

To implement a plan of this type, several sacrifices would have to be made in the quality of pretreatment achieved to avoid excessive additional costs. Daily municipal-industrial flows would receive high quality secondary treatment; however, to allow dual use of the major transmission lines to the storage system and irrigation areas, it would be necessary to give storm flows only the equivalent of primary treatment in the stormwater equalization lagoons. This would not greatly affect the average quality of irrigation water. Disinfection would be necessary prior to distribution.

There would be no significant reduction in land required for the Monroe and St. Clair County lagoon systems since storage lagoons would still be necessary and the aerated lagoons required only a small percentage of the total required land. Land required for sludge would be significantly reduced since incineration would be employed at treatment plant sites rather than land application at the lagoon sites.

Total energy requirements would not change significantly. The location of the demands would be shifted from lagoon sites to treatment plant sites. Those resource demands affected by the use of incineration, such as fuel and air emissions, would change.

The total cost of the system, both capital and operational, would not be expected to change significantly.

Interim Water Quality Plan

The Interim Water Quality Plan has been derived from the State of Michigan's water quality plan. It is presented as an Interim Plan, because, depending on the interpretation of Public Law 92-500, this plan could satisfy the 1983 requirement of "best practicable technology."

The Interim Water Quality Plan should be capable of achieving "wherever attainable . . . a water quality which provides for the protec-

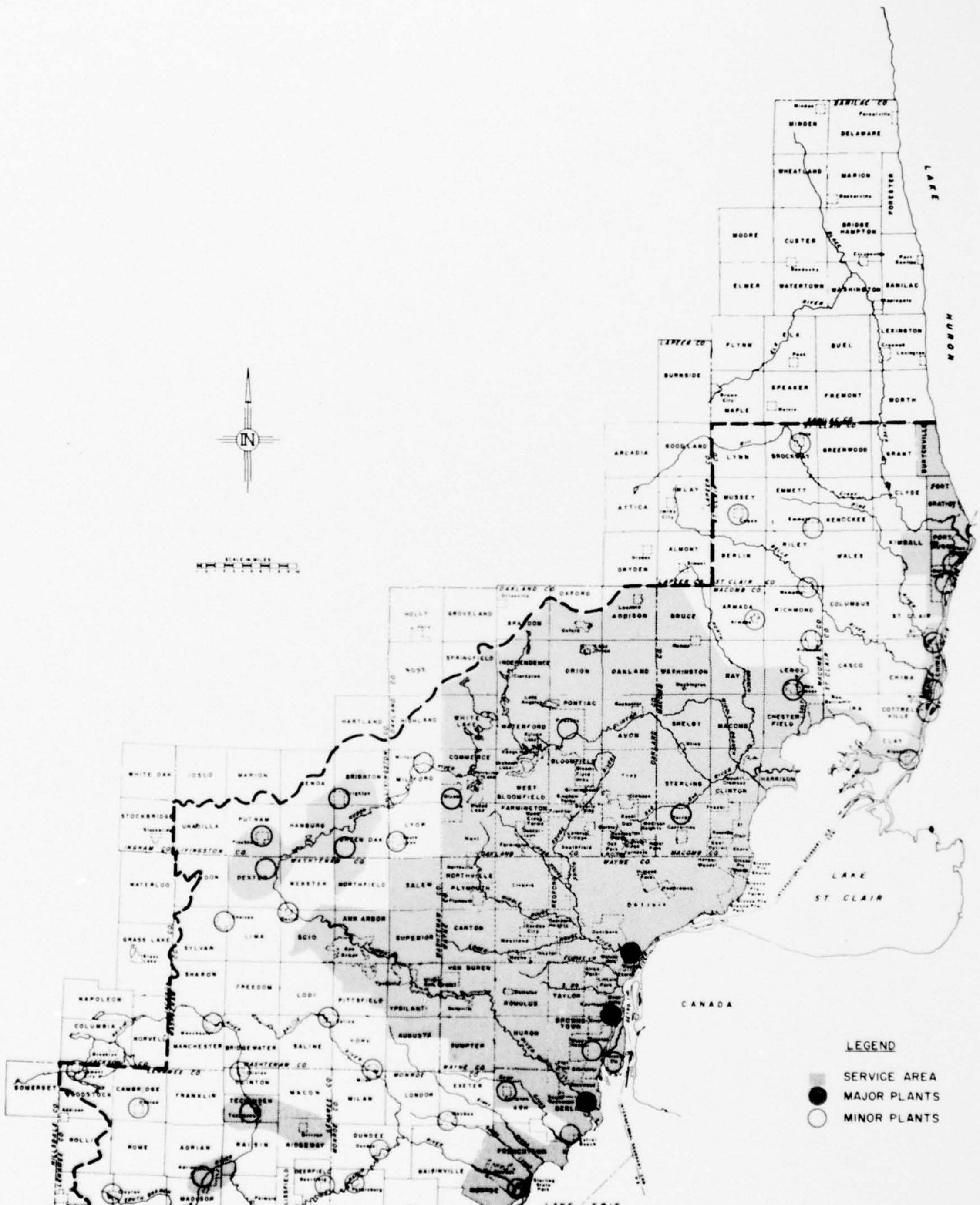

FIGURE 24

INTERIM WATER QUALITY PLAN

MUNICIPAL, INDUSTRIAL & COMBINED SEWER OVERFLOW WASTEWATER

tion and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water." Most of the information used in the development processs came from the Water Resources Commission Phase II Plan for Southeastern Michigan.

In this plan, 46 wastewater treatment plants in the area would provide treatment of municipal and industrial wastewater, and overflow from the combined sewers. Three regional plants, located in Detroit, Wyandotte and at the Huron River, would have a total design-treatment capacity of 1420 million gallons per day (MGD). Forty-three minor plants, having a total design capacity of 160 MGD, would serve communities that are not a part of a regional system (see Table 12). Plant locations can be seen on Figure 24. Many of the minor plants are considered interim facilities to provide treatment until growth of the community would justify further extension of the regional interceptor system.

The degree of treatment required at a particular plant depends upon the water body into which the plant discharges. Plants which discharge directly to the St. Clair River, the Detroit, River, or Lake Erie would be required to provide an equivalent of secondary treatment and remove a minimum of 80 percent of the phosphorus. Plants discharging to inland streams would be required to provide a higher degree of treatment as shown in Table 11 below.

TABLE 11

EFFLUENT REQUIREMENTS
FOR PLANTS DISCHARGING TO INLAND STREAMS

5 - Day BOD	4.0 mg/l
Ammonia Nitrogen	0.5 mg/l
20 - Day BOD	8.0 mg/l
DO in the effluent	5.0 mg/l minimum

TABLE 11 (Cont'd)

Total Phosphorus Removal	80% minimum
Suspended Solids	15.0 mg/l
Fecal Coliform	100/100 ml
Total Coliform	1000/100 ml

Additional interceptors will be required to provide transporation of wastewater being generated from the newly developed portions of the 1990 service area. The Detroit collection system would be expanded to serve developing portions of Macomb and Oakland Counties. Additional interceptors would also be built to relieve overloaded portions of the existing combined sewer system most prevalent in older portions of the service area. The collection system, which terminates at the Wyandotte plant, would remain unchanged, since it is not expected to expand. The area it serves is already developed to a large degree. The collection system which would lead to the proposed Huron River Plant would have to be constructed in its entirety. This sewerage system would serve a major portion of the new development in Southeastern Michigan.

Sewage sludges in all but two of the plants would be incinerated. Incineration is primarily for volume reduction and stabilization before final disposal in a landfill. The relatively limited availability of landfills near the large urban plants has made this method feasible.

The two plants which would not have incinerators, Algonac and Adrian, would dewater the sludge and landfill it. These plants are fortunate to be in locations where landfill sites are available and are within economic haul distance from the plant. The quantity of sludge produced at these two plants is also small enough that the quantities are not a limiting factor.

The combined sewered systems of Southeastern Michigan contribute a significant pollutant load to the surface waters of the area through by-passes and overflows. To meet the water quality goals of the region, three plans were developed for controlling the combined sewer overflows and, thus, limiting the total pollutants discharged to a receiving stream. In each plan, a specified volume of combined sewer overflows would be stored in numerous facilities constructed throughout the area. These facilities would provide for the retention of floating debris by skimming, chlorination for effective disinfection of the overflows which would occur when the storage capacity is exceeded, and the removal of septic solids buildup deposited by smaller retained storms over an extended period. From storage, the retained stormwater would be reintroduced into the interceptor system at a lower rate and treated at the same facility used to treat the municipal-industrial flow from the area. The most extensive storage system was selected since the other two plans would probably not be sufficient to meet the interim water quality goals. The location and type of storage are not shown on the figure as they have not yet been defined.

Implementation of this plan would produce impacts in varying degrees on the environment, resources, public health, the economy and the individuals in the area. Table 13 lists the significant impacts, identified by the evaluators, which may result from implementation of this plan. Each impact is indicated under the column which identifies the primary area affected. Other areas which would also be affected are identified and the relative degree of effect is also indicated.

Table 12

INTERIM WATER QUALITY PLAN

	Design Treatment Capacity (MGD)	Sludge Disposal Method*	Additional Land Required (Acres)	Capital Cost $Million	Annual O&M Cost $Million	Total Annual Cost $Million
Major Wastewater Plants						
Detroit	1200	INC	50	162	13.4	23.0
Huron River	121	INC	42	36	1.7	3.8
Wyandotte	100	INC	17	--	1.4	1.4
Minor Wastewater Plants						
Warren	36	INC	--	--	0.5	0.5
Pontiac	30	INC	7	9	0.6	1.1
Monroe	24	INC	--	--	0.4	0.4
Port Huron	20	INC	5	--	0.4	0.4
Algonac	8.3	LF	7	5	0.2	0.5
Adrian	7.5	LF	3	1	0.2	0.3
Trenton	5.5	INC	--	2	0.2	0.3
Others				44	1.0	3.6
Wastewater Interceptors and Transmission Lines				435	--	25.7
Combined Sewer Relief System				1,495	3.5	91.8
Sludge Landfills			650	(Costs included in plant costs)		
SYSTEM TOTALS	1554		781	2,270	20.0	152.8

*INC: sludge incineration; LF: sanitary landfill of sludge

TABLE 13

INTERIM WATER QUALITY PLAN
IMPACT IDENTIFICATION TABLE

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
I. WATER QUALITY			
A. SURFACE WATERS		Significant improvement could be expected in the water quality in the St. Clair, Clinton, Rouge, Huron, Detroit, Raisin and other inland rivers; however, lower water quality following storms would continue due to uncontrolled discharge of separate sewered urban storm runoff.	
		Peak storm flows would be equalized somewhat in the Rouge and Clinton Rivers due to the combined sewer overflow storage system.	
		Unless supplementary water supply was developed for the Ann Arbor-Ypsilanti area, abnormally low flows could occur in the lower Huron River.	
B. GROUND WATER	Ground water contamination could result from poorly managed disposal of stormwater solids and unincinerated sewage sludges.		
II. AQUATIC LIFE AND WATERFOWL		Habitats for intollerant game fish would be significantly improved in southeastern Michigan rivers and streams; however, artificial stocking would be required to maintain populations.	
III. PUBLIC HEALTH		Pathogen contamination from treatment plant effluents and combined sewer overflow would be reduced significantly; however, complete disinfection would not be achieved.	
		Infectious disease could be spread by waterfowl or other animals allowed access to surface stormwater storage lagoons.	
	A potential hazard would exist where large quantities of chlorine would be handled (On site chlorine production would significantly reduce the hazard).		
	Increased concentrations of pathogens could be expected in the air in the vicinity of activated sludge aeration basins.		
IV. ENERGY AND NATURAL RESOURCES A. AIR		Some gaseous (NO_x and SO_x) and particulate matter would be emmitted from sewage sludge incinerators.	
	A plume would be visible at incineration sites due to condensed water vapor.		
B. CHEMICALS		14,000 tons of chlorine (or raw materials, salt and electrical energy: 2600 kwhr/ton Cl_2) would be consumed annually.	
		Chemicals required for phosphorus removal would include lime, waste pickle liquor, iron salts, alum or other commercial chemicals. Quantities would be significant but have not been determined.	
C. ELECTRICAL POWER		132 megawatts of electrical power would be required to operate wastewater treatment plants. Additional electrical power would be required to operate the stormwater storage system.	
D. FUEL OIL OR NATURAL GAS		10 billion BTU of heat energy from fuel oil or natural gas would be required daily for sludge incineration.	

The comments in this table are intended to identify impacts only; each comment appears under the column identifying the area of greatest significance. The relative significance for other areas is identified by the screening indicated in the index to the right.

Equally Significant

Partially Significant

Somewhat Significant

Insignificant

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
This plan would satisfy the water quality goals of the State of Michigan.		This plan could meet the interim (July 1983) water quality goals of P. L. 92-500 but if implemented would preclude achievement of the ultimate goals of the law by 1985.	This plan would meet the intent of the April,1972 agreement with Canada on Great Lakes water quality.
	Employment of this degree of wastewater treatment throughout the Lake Erie basin would probably not be effective in achieving nutrient concentrations which would reduce algae problems in the lake.		
	Although lake water quality would be improved through implementation of this plan, the effects would not be obvious to the observer.		
	Any improvement in water quality in Lake Erie would not have an effect on fisheries in the lake unless proper management was practiced in the commercial fishing industry.		
	Improved wastewater management would be beneficial to waterfowl since habitats would be improved and concentrations of toxic substances and oils would be reduced.		

TABLE 13

INTERIM WATER QUALITY PLAN
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
V. EMPLOYMENT		Labor demands for construction would cover a period of 10-12 years. Depending upon the design of the stormwater storage system, labor demands could exceed local supply.	
		Unemployment in the construction trades would be expected to drop with the advent of construction and increase upon completion of the project.	
		Operating manpower requirements for the wastewater plants would be 1500. Additional manpower would be required to staff the stormwater storage system.	
VI. LAND AND WATER USE CHANGES	Land use would have to be changed for the plant at the Huron River, for plant expansion at Wyandotte and Detroit, and for construction of the stormwater storage system.		
		The areas surrounding new treatment and storage facilities have a potential use by local units of government as open space and recreational areas.	
		Improved water quality in Lake St. Clair and inland rivers would allow increased development of water based recreation.	
VII. LAND VALUES	Some loss of property value may be experienced in the vicinity of wastewater management facilities due to the stigma associated with such facilities.		
		Land values along southeastern Michigan shorelines should increase due to improved water quality over the area and peak flow reduction in the Rouge and Clinton Rivers.	
VIII. AREA ECONOMY AND INSTITUTIONS		The history of growing intergovernmental cooperation in southeastern Michigan lays the basis for a regional approach to wastewater management.	
		781 acres of land for wastewater treatment plants and additional land for stormwater storage facilities would be removed from the tax base of local and county governments.	
		The regional economy would be stimulated temporarily due to demands for construction materials and increased construction payrolls.	
		There would be an area-wide decrease in disposable income of each family due to increased sewer charges to offset costs shown in X. below.	
		Implementation of the plan would be contrary to the goals of some communities, particularly Ann Arbor, which desire to maintain autonomy.	
		The creation of an unpolluted water supply would not have a significant effect on existing enterprizes, nor is it apt to attract new types of economic activity.	
IX. SOCIO-ECONOMICS	Owners of economic establishments and residents of lands required for construction of wastewater facilities would have to be relocated.		
	Residents of lands near proposed facilities would have their normal lifestyle disrupted and commercial enterprizes near-by would be affected while construction operations where underway.		
		The system would help satisfy a regional need for expanded water based recreation by providing more waters suitable for total body contact recreation.	
X. SYSTEM COSTS			
A. CAPITAL COSTS		$ 547,000,000	
B. AMORTIZED CAPITAL COST (Average annual)		32,000,000	
C. OPERATION AND MAINTENANCE (Average annual)		24,000,000	
D. TOTAL AVERAGE ANNUAL COST		56,000,000	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
	Improved water quality in Lake Erie through basin wide wastewater management could offer improved potential for development of water based recreation.		
		$ 1,643,000,000 97,000,000 - - 97,000,000	

Chapter 6

FORMATION OF REPRESENTATIVE PLANS

REPRESENTATIVE PLANS

The design and evaluation work described in the previous chapter led to the final selection of representative plans. The evaluation of the original and second stage alternatives on the basis of technical, economical, institutional, aesthetic, ecological, and social considerations resulted in changes to improve the overall acceptance of the most favorable of these alternatives.

The three representative alternative plans differ in the method of treatment employed in the Adrian-Tecumseh area and in the southern portion of St. Clair County, while much of the other facilities are the same. Thus, the representative plans could be considered as one plan with three variations or sub-systems. Common to each representative plan is the use of three existing wastewater treatment plants located in Detroit (W. Jefferson Avenue), Wyandotte, and Monroe. These plants would be upgraded to advanced wastewater treatment plants to make use of the existing facilities, especially those which have just been added or are currently under construction. The existing wastewater treatment plant in Port Huron would be converted to an independent physical-chemical treatment plant, because the additional land required for adding advanced wastewater processes to the existing secondary facilities would not be easily acquired. A new plant at the Huron River would also be common to all plants. This plan would be an independent physical-chemical facility, because it is the most cost effective method of providing treatment for that area.

All treatment facilities have been designed to meet a minimum effluent standard of:

BOD	4 mg/l
COD	10 mg/l
Suspended Solids	2 mg/l
Total Phosphorus	0.1 mg/l
Ammonia Nitrogen	0.3 mg/l
Total Nitrogen	3.0 mg/l

In addition, most heavy metals, synthetic organic chemicals and pesticides would be reduced to trace levels; thus, the effluent would be relatively free of pathogens.

Most of the interceptor sewer system necessary for this plan will be in place by 1985. The additional major interceptor construction necessary for implementation of this plan would include: an interceptor along the shoreline in southern St. Clair County to the East China plant, an interceptor along the Detroit River to the Huron River plant, an interceptor from Ann Arbor following the Huron River to its mouth, and an interceptor following Hannan Road north of the Huron River.

The system, designed for handling combined sewer overflow and urban storm runoff, would be essentially independent of the municipal-industrial wastewater treatment system. The stormwater system would utilize forty-nine community storage reservoirs ranging in size from 80 to 690 acres. These and two regional reservoirs of 3120 acres each would be used for temporary storage of peak storm flows. Four stormwater treatment facilities would also be common to all plans. They would be independent physical-chemical treatment facilities because advanced wastewater treatment for stormwater cannot be operated in a manner that responds satisfactorily to the intermittent nature of stormwater flows. One of these plants would be constructed as part of regional facilities at the Huron River because similar treatment processes make it economically advantageous and more effi-

cient to integrate portions of the separate treatment facilities. Another plant would be located at the regional storage reservoir in Macomb County for most efficient operation. The remaining stormwater plants would be independent facilities located near Plymouth and Ypsilanti. These plants would discharge a treated stormwater effluent which would have normally been a part of the natural flow of the river. The discharge rate would be more uniform, however, and the quality much higher.

An extensive system of interceptors and tunnels would be required to collect storm runoff and combined sewer overflows at the present points of discharge to surface waters. Normal sewer construction techniques would be utilized in less urbanized areas; however, the greater size of sewers required in highly urbanized areas and the construction problems encountered made design of hard rock tunnels necessary.

Sludges generated at the common wastewater treatment plants would be incinerated in order to reduce the amount of land required for filling the sludge and to reduce hygienic hazards from handling the sludge. All sludges from lime clarification processes would be recalcined both to reclaim the lime and to reduce the volume of waste sludge. The solids which would accumulate in stormwater storage lagoons would be removed periodically and disposed of in a landfill.

Representative Plan 1

Representative Plan 1, shown in figure 25, emphasizes wastewater treatment by plants on a regional scale. In addition to the facilities common to each plan, small communities outside the regional service area would operate individual treatment plants until growth might warrant extension of regional interceptors.

The regional service areas in Lenawee County and south St. Clair County would be serviced by independent physical-chemical treatment plants

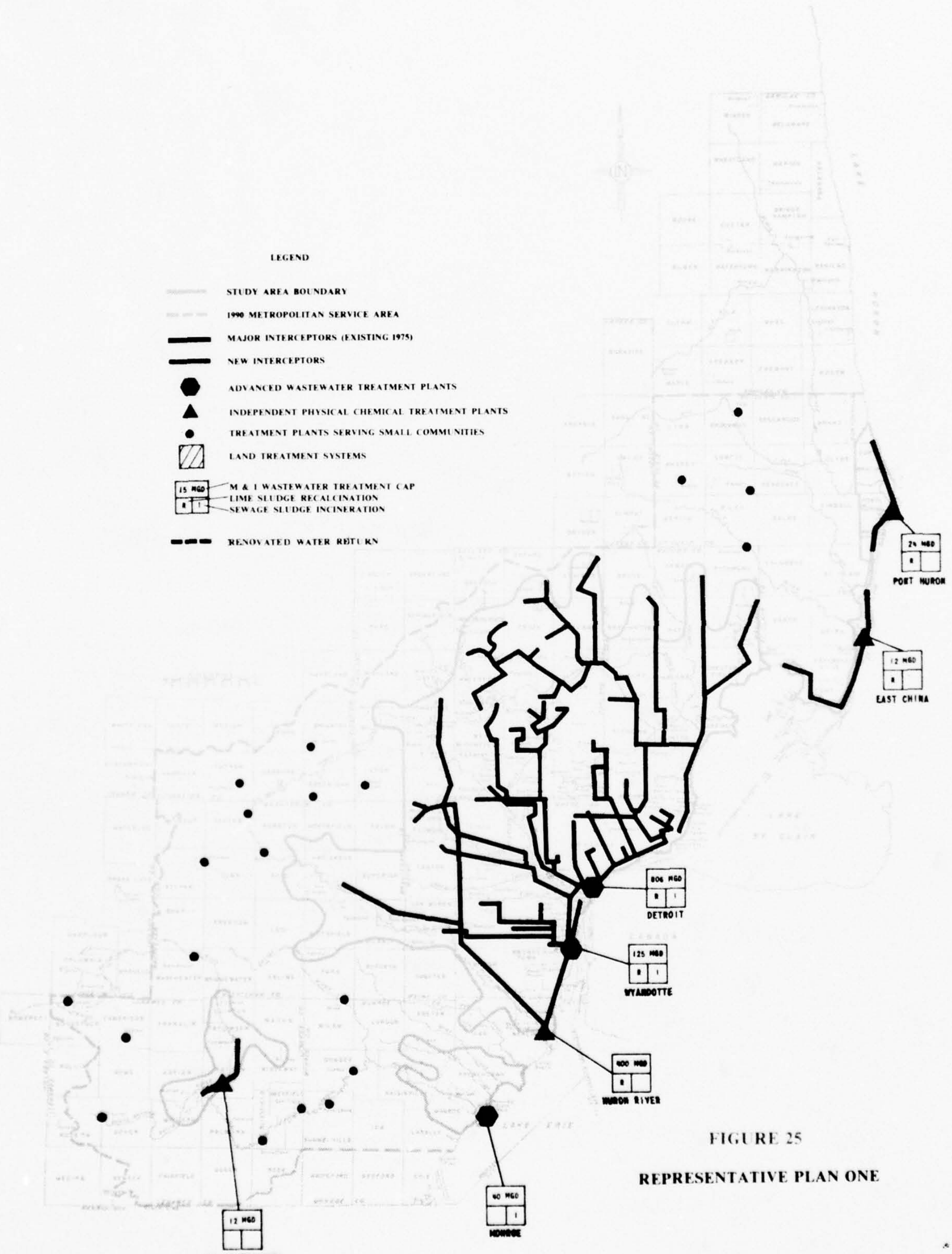

FIGURE 25

REPRESENTATIVE PLAN ONE

east of Adrian and at East China Township. The IPCT process would be the most economical type of treatment at these locations. The stormwater treatment plants for these areas would be collocated IPCT plants at these sites for economy and efficiency. The stormwater control system for this alternative is shown in figure 26. A summary of the features of this alternative is in Table 14.

Representative Plan 2

Representative Plan 2, as shown in figure 27, has both land irrigation and treatment plants in portions of the plan. Land irrigation techniques would be used in central Lenawee and southern St. Clair County for treatment of both stormwater and municipal-industrial wastewater from these areas. The stormwater control system for this alternative is shown in figure 28. In each system the wastewater would be treated in aerated lagoons, disinfected, then irrigated on farmlands owned and managed by the operating agency. Sludge from the St. Clair and Lenawee County treatment lagoons would be applied to the land on adjacent sludge disposal sites.

The major portion of the region's wastewater would be treated by the common system described earlier in this section. Small communities outside of the regional service area would operate individual treatment plants until growth would warrant extension of the regional interceptors. A summary of the features of this alternative is in Table 15.

Representative Plan 3

In Representative Plan 3, as shown in figures 29 and 30, the major portion of the region's wastewater would be treated in the plant system common to all plans. Land irrigation treatment would be employed for treating both municipal-industrial and stormwater in southern St. Clair County and central Lenawee County. In each system the wastewater would be treated in aerated lagoons, disinfected, and distributed to nearby farmers for irri-

Table 14

REPRESENTATIVE PLAN ONE
DESIGN AND COST INFORMATION SUMMARY

	Facility Capacity (MGD) and Type		Sludge Disposal Method*	Land Required (Acres)	Capital Cost $ Million	Annual O&M Cost $ Million	Total Annual Cost $ Million
	Mun-Ind	Storm					
Wastewater Treatment Plants							
Port Huron	24 IPCT	--	REC, LF	--	10.9	1.5	2.3
Detroit	806 AWT	--	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	--	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	--	INC,LF	50	33.3	3.1	5.1
Huron River	400 IPCT	1000 IPCT	REC,LF	350	493.3	35.1	66.0
Macomb County	--	600 IPCT	REC,LF	160	181.5	8.3	19.2
Plymouth	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
Ypsilanti	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
East China	12 IPCT	125 IPCT	REC,LF	80	57.8	3.0	6.6
Adrian-Tecumseh	12 IPCT	10.5 IPCT	REC,LF	20	11.3	0.8	1.6
Wastewater Interceptors and Transmission Lines					214.8	0.9	13.5
Stormwater Collection, Storage and Transmission			LF	23,500	256.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,141	6.5	1.1	1.6
Lenawee Co.				2,402	11.7	2.0	2.8
SYSTEM TOTALS	1419	2185.5		28,073	4,183.7	119.6	370.6

*REC: Recalcination of Lime sludge; LF: Landfill; INC: Incineration

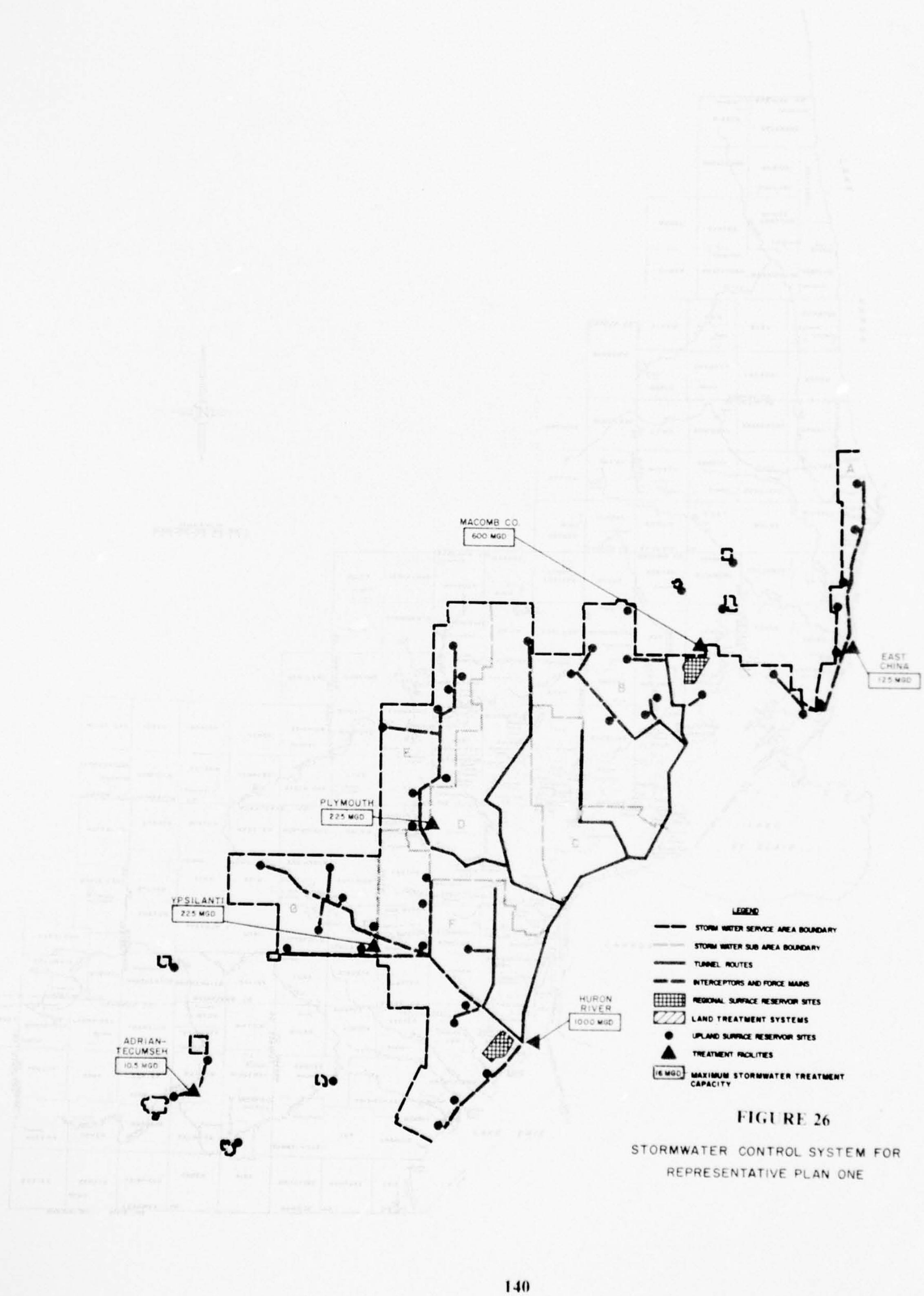

FIGURE 26

STORMWATER CONTROL SYSTEM FOR REPRESENTATIVE PLAN ONE

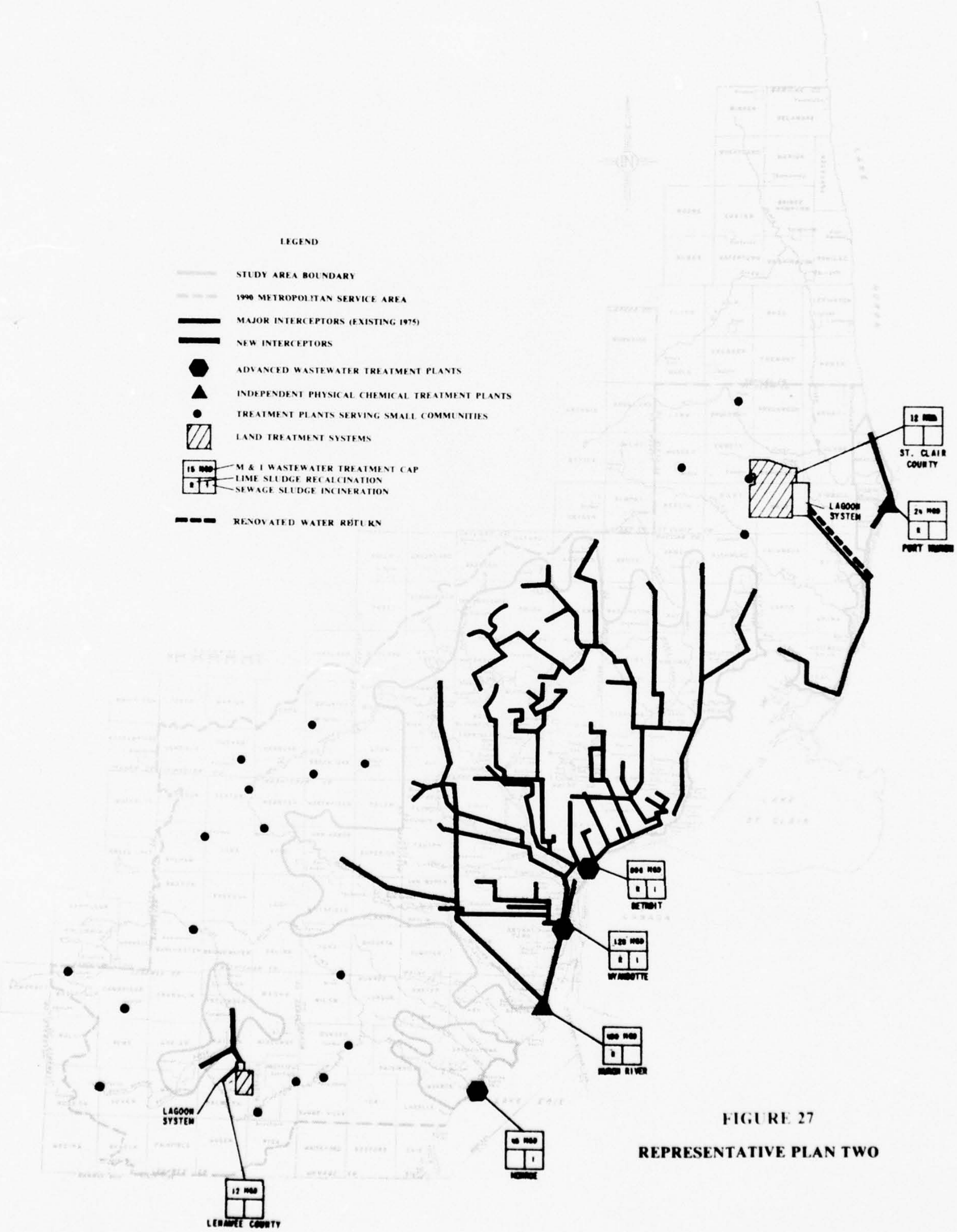

FIGURE 27

REPRESENTATIVE PLAN TWO

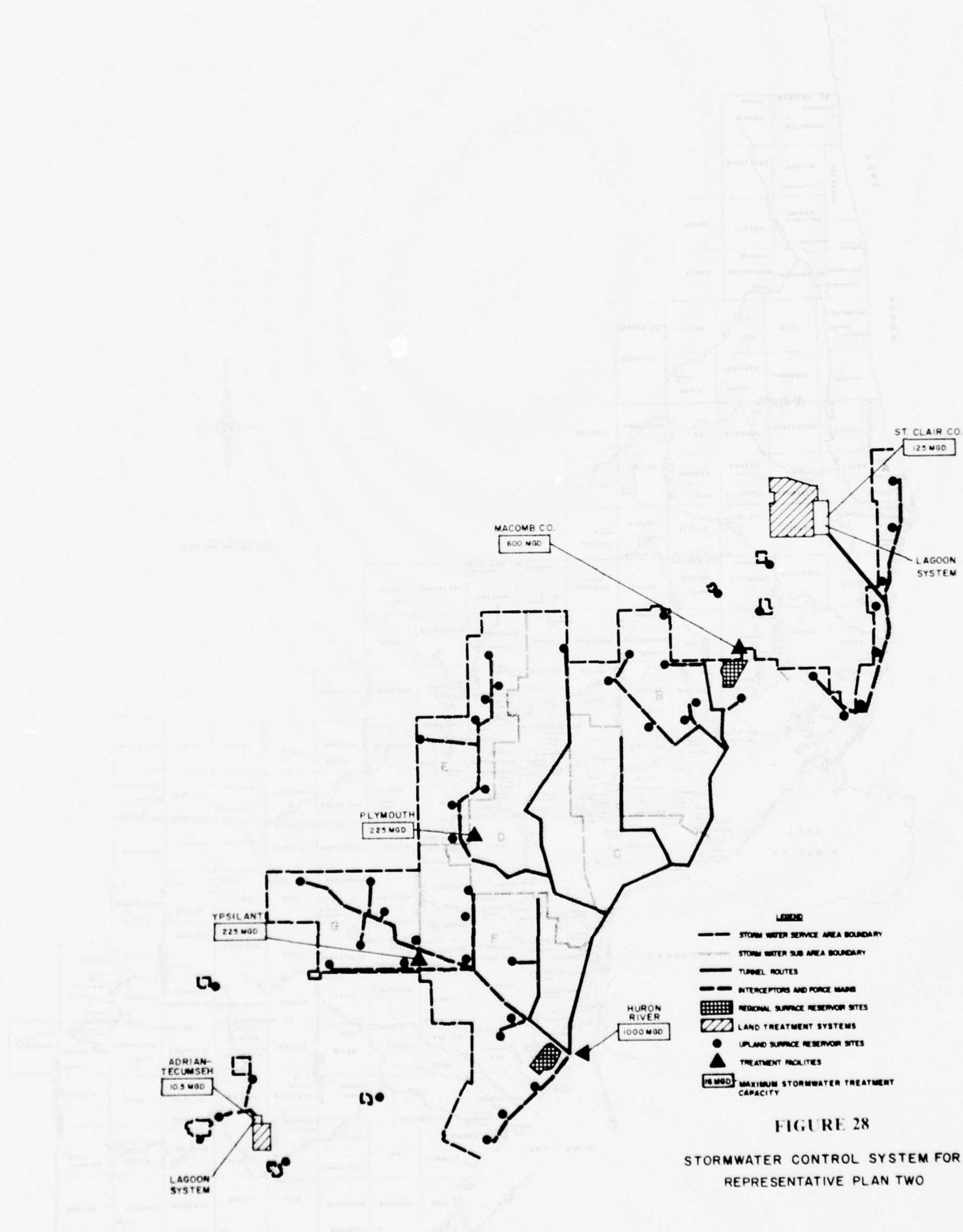

FIGURE 28

STORMWATER CONTROL SYSTEM FOR REPRESENTATIVE PLAN TWO

Table 15
REPRESENTATIVE PLAN TWO
DESIGN AND COST INFORMATION SUMMARY

	Facility Capacity (MGD) and Type		Sludge Disposal Method*	Land Required (Acres)	Capital Cost $ Million	Annual O&M Cost $ Million	Total Annual Cost $ Million
	Mun-Ind	Storm					
Wastewater Treatment Plants							
Port Huron	24 IPCT	--	REC, LF	--	10.9	1.5	2.2
Detroit	806 AWT	--	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	--	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	--	INC, LF	50	33.3	3.1	5.2
Huron River	400 IPCT	1000 IPCT	REC, LF	350	493.3	35.1	66.0
Macomb Co.	--	600 IPCT	REC, LF	160	181.5	8.3	19.2
Plymouth	--	225 IPCT	REC, LF	85	73.8	3.3	7.8
Ypsilanti	--	225 IPCT	REC, LF	85	73.8	3.3	7.8
Land Treatment Systems							
St. Clair Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	125 LAND	LA	22,356	70.3	3.1	7.2
Lenawee Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	10.5 LAND	LA	4,775	23.4	0.7	2.1
Wastewater Interceptors and Transmission Lines					264.1	1.6	17.4
Stormwater Collection, Storage and Transmission			LF	23,500	2,561.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,073	6.2	1.1	1.5
Lenawee Co.				2,338	11.3	1.9	2.7
SYSTEM TOTALS	1,419	2,185.5		55,192	4,256.9	120.2	375.6

*REC: Recalcination of lime sludge; LF: Landfill; INC: Incineration;
LA: Land application
Capital cost ammortization and total annual costs are based on 5.5% interest over 50 years.

Table 16
REPRESENTATIVE PLAN THREE
DESIGN AND COST INFORMATION SUMMARY

	Facility Capacity (MGD) and Type		Sludge Disposal Method*	Land Required (Acres)	Capital Cost $ Million	Annual O&M Cost $ Million	Total Annual Cost $ Million
	Mun-Ind	Storm					
Wastewater Treatment Plants							
Port Huron	24 IPCT	--	REC, LF	--	10.9	1.5	2.2
Detroit	806 AWT	--	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	--	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	--	INC, LF	50	33.3	3.1	5.2
Huron River	400 IPCT	1000 IPCT	REC, LF	350	493.3	35.1	66.0
Macomb Co.	--	600 IPCT	REC, LF	160	181.5	8.3	19.2
Plymouth	--	225 IPCT	REC, LF	85	73.8	3.3	7.8
Ypsilanti	--	225 IPCT	REC, LF	85	73.8	3.3	7.8
Land Treatment Systems							
St. Clair Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	125 LAND	LA	2,576 (57,200)**	199.5	8.7	20.6
Lenawee Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	10.5 LAND	LA	815 (15,320)**	62.3	2.3	6.0
Wastewater Interceptors and Transmission Lines					336.7	2.5	23.0
Stormwater Collection, Storage and Transmission			LF	23,500	2,561.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,073	6.2	1.0	1.5
Lenawee Co.				2,338	11.3	1.9	2.7
SYSTEM TOTALS				31,452 (72,520)**	4,497.6	128.3	398.3

*REC: Recalcination of lime sludge; LF: Landfill; INC: Incineration
LA: Land application
**Land required for irrigation to remain in private ownership.
Capital cost ammortization and total annual costs are based on 5.5% interest over 50 years.

FIGURE 29

REPRESENTATIVE PLAN THREE

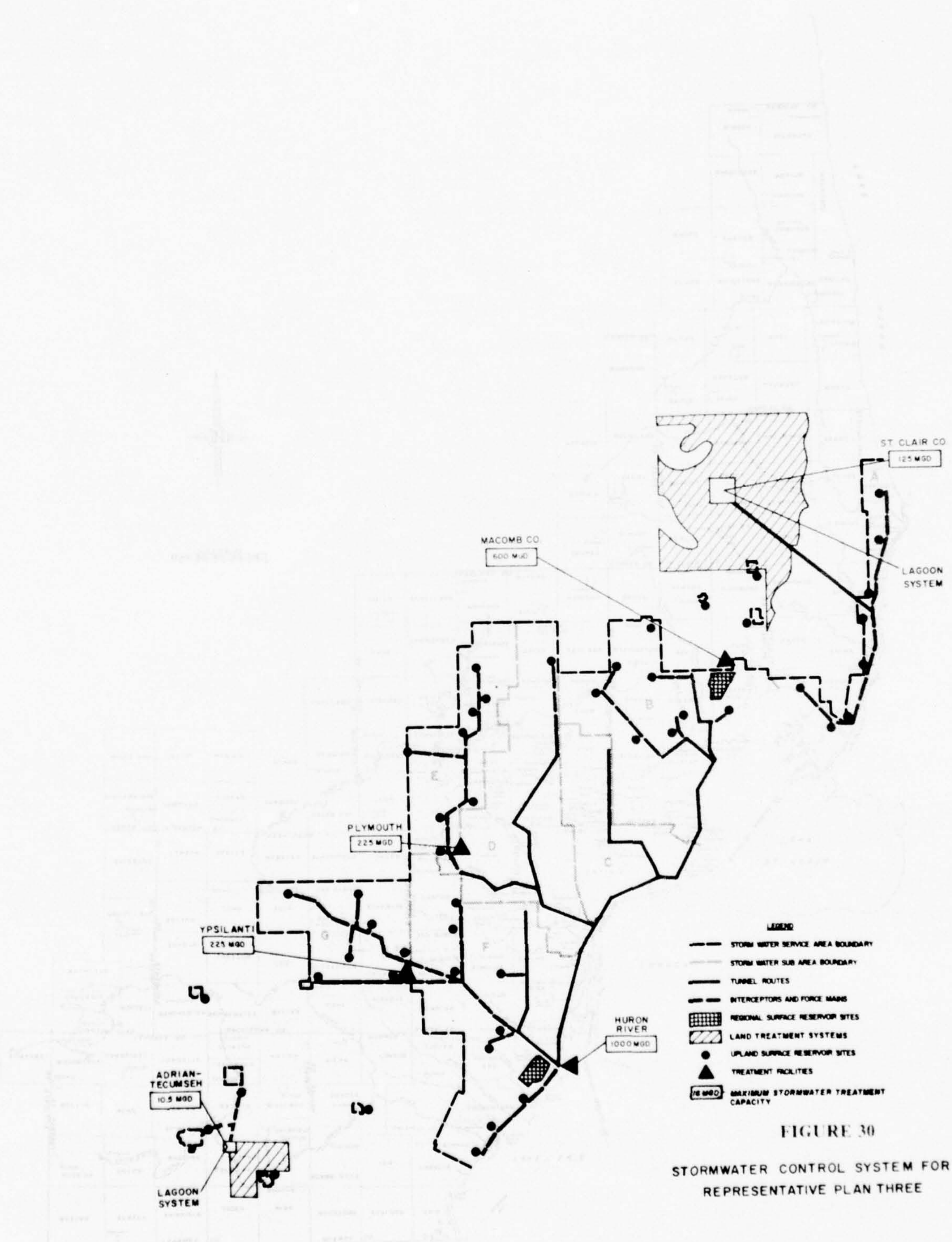

FIGURE 30

STORMWATER CONTROL SYSTEM FOR REPRESENTATIVE PLAN THREE

gation on their land. This land would remain under the ownership and control of the individual farmer or land owner. Sludge from the treatment lagoons in St. Clair and Lenawee Counties would be applied to special sludge disposal sites adjacent to the lagoons. Small communities outside of the regional service area would operate individual treatment plants until growth would warrant extension of the regional interceptors. A summary of the features of this alternative is in Table 16.

DISCUSSION OF IMPACTS

Four plans, Representative Plans 1, 2, and 3 and the Interim Water Quality Plan, were presented for consideration in the selection of a wastewater management plan for the Southeastern Michigan area. Impact identification tables were prepared for each of the four plans and can be found in the Evaluation Appendix. The tables identify impacts which would be realized if the plan were implemented. Many of the impacts, however, could only be identified as potential impacts that would require additional study if it became a significant factor in plan selection. The tables served only to identify impacts and did not attempt to relate the impacts to another plan.

To simplify the discussion of the impacts of the four final plans, only two of the impact tables will be used. Table 12, the Interim Water Quality Plan Impact Identification Table, was presented in the preceding section and will be referred to in discussion of the Interim Water Quality Plan. Table 17, the Representative Plan One Impact Identification Table, will be used to discuss all three of the representative plans due to the similarity of the three plans.

Water Quality

Only the three representative plans would be capable of approaching the goal of "no discharge of pollutants" by 1985. The Interim Water Quality

TABLE 17

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION PLAN

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
I. WATER QUALITY			
A. SURFACE WATERS		Significant improvements could be expected in the water quality in the St. Clair, Clinton, Rouge, Huron, Detroit and Raisin Rivers due to elimination of urban stormwater and wastewater discharges.	
		Peak storm flows would be equalized in the Rouge, Huron and Clinton Rivers due to stormwater storage facilities.	
B. GROUND WATER	Ground water contamination could result from poorly managed sludge landfill areas (primarily nitrates and heavy metals).		
II. AQUATIC LIFE AND WATERFOWL		Habitats for intolerant game fish would be improved; however, artificial stocking would be required to maintain populations.	
III. PUBLIC HEALTH		Pathogen contamination from treatment plant effluents and uncontrolled discharge of urban storm runoff and combined sewer overflow would be virtually eliminated.	
		Infectious disease could be spread by waterfowl or other animals allowed access to stormwater storage lagoons.	
	A potential hazard would exist where large quantities of chlorine would be handled (On site chlorine production would significantly reduce the hazards).		
	Increased concentrations of pathogens could be expected in the air in the vicinity of treatment plant aeration basins.		
IV. ENERGY AND NATURAL RESOURCES A. AIR		Some gaseous (NO_x and SO_x) and particulate matter would be emmitted from incineration, lime sludge recalcination and carbon regeneration facilities at treatment plant sites.	
	A plume would be visible at incineration and lime sludge recalcination sites due to condensed water vapor.		
B. CHEMICALS		155,000 tons of chlorine (or raw materials, salt and electrical energy: 2600 kwhr/ton Cl_2) would be consumed annually.	
		570,000 tons of lime (or raw materials, limestone rock and heat energy: 4.25-8.25 million BTU/ton lime) would be consumed annually.	
		51,000 tons of methanol (brewery waste could be substituted) would be consumed annually.	
C. ELECTRICAL POWER		The average electrical power demand of 265 megawatts is within the planned capabilities of Detroit Edison.	

The comments in this table are intended to identify impacts only; each comment appears under the column identifying the area of greatest significance. The relative significance for other areas is identified by the screening indicated in the index to the right.

Equally Significant	Somewhat Significant
Partially Significant	Insignificant

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
This plan would result in water of higher quality than presently required by the State of Michigan.		This plan meets the intent and time-phased goals of Public Law 92-500.	This plan would comply with the April [illegible] agreement with Canada on Great Lakes water quality.
	There is little potential for significant improvement in the western half of Lake Erie with respect to algal blooms and oxygen depletion.		
	If similar wastewater management projects were carried out in the remainder of the Lake Erie basin, ecological recovery may be possible in the eastern half of the lake.		
	Although the habitat for intollerant fishes would be improved in Lake Erie, improvement of fisheries will depend on management practices in the commercial fishing industry.		
	Waterfowl populations may improve due to improved habitats and food supplies.		

TABLE 17

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
C. ELECTRICAL POWER (Continued)		The additional 1850 megawatts required for peak stormwater pumping would be met by stand-by generators which could also serve as emergency back-up to the regional power grid.	
D. FUEL OIL OR NATURAL GAS		33 billion BTU of heat energy from fuel oil or natural gas would be required daily.	
V. EMPLOYMENT		Labor demands for construction would cover a period of 10-12 years. The demands for that period would exceed the local supply thus requiring labor from outside the region.	
		Unemployment in the construction trades would be expected to drop with the advent of construction and increase upon completion of the project.	
		The total operating manpower required would be 3249. Special training programs would be necessary to meet demands for technicians and specialty labor categories.	
VI. LAND AND WATER USE CHANGES	Essentially all of the proposed facilities would somewhat alter existing and proposed land use.		
		Buffer areas specified for most wastewater facilities have potential use by local units of government for open space or recreational areas.	
		Implementation of this plan would necessitate development of a supplementary water source for the Ann Arbor-Ypsilanti area to avoid abnormally low flows in the Huron River.	
	A potential would exist for developing local industrial water supplies utilizing renovated wastewater particularly in the vicinity of facilities near Adrian, Ypsilanti, Plymouth and the Huron River. Industrial expansion could thus be encouraged in areas previously not industrially oriented.		
VII. LAND VALUES		Land values along southeastern Michigan shorelines should increase due to improved water quality over the area and peak flow reduction in the Rouge and Clinton Rivers.	
	Some loss of property value may be experienced in the vicinity of wastewater management facilities due to the stigma associated with such facilities.		
VIII. AREA ECONOMY AND INSTITUTIONS		The history of growing intergovernmental cooperation in southeastern Michigan lays the basis for a regional approach to wastewater management.	
		Implementation and operation of this alternative would require one or several management organizations having a number of comprehensive management capabilities (i.e. planning, financing, construction, operation, maintenance and administrative capabilities).	
		Implementation of this plan would be contrary to the goals of some communities, particularly Ann Arbor, Pontiac and Warren, which desire to maintain autonomy.	
		28,200 acres of land would be removed from the tax base of local and county governments.	
		All existing treatmentt facilities in the service area with the exception of Detroit, Wyandotte, Port Huron and Monroe would be phased out by 1985.	
		The regional economy would be stimulated temporarily due to demands for construction materials and increased construction payrolls.	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA — INTERNATIONAL

TABLE 17

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
VIII. AREA ECONOMY AND INSTITUTIONS (Continued)		Gross income in the area would increase due to increased wastewater system payrolls; however, *there be an area-wide decrease in disposable income* of each family due to increased sewer charges to offset costs shown under X. below.	
		The creation of an unpolluted water supply would not have a significant effect on existing economic enterprizes, nor is it apt to attract new types of economic activity.	
IX. SOCIO-ECONOMICS	Owners of economic establishments and residents of lands required for construction of wastewater facilities would have to be relocated.		
	Residents of lands near proposed facilities would have their normal lifestyle disrupted and commercial enterprizes near-by would be affected while construction operations were underway.		
		The system would help satisfy a regional need for expanded water based recreation by providing more waters suitable for total body contact recreation.	
X. SYSTEM COSTS			
A. CAPITAL COSTS		$ 1,046,000,000	
B. AMORTIZED CAPITAL COST (Average annual)		62,000,000	
C. OPERATION AND MAINTENANCE (Average annual)		123,000,000	
D. TOTAL AVERAGE ANNUAL COST		185,500,000	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
		$ 3,137,000,000 185,000,000 - - 185,000,000	

Plan could possibly achieve the 1983 objectives. The water quality objective of the State of Michigan and the objectives outlined in the April, 1972 agreement between the United States and Canada on Great Lakes water quality could be met by each of the four plans.

Implementation of any one of the four plans would result in significant improvements in the water quality of the inland rivers. The centralization of treatment facilities along the St. Clair and Detroit Rivers and Lake Erie would reduce the number of inland wastewater and combined sewer overflow discharges. Inland river water quality is expected to be higher for the Representative Plans than for the Interim Plan since urban storm runoff from separately sewered areas is addressed in the former. Each of the Representative Plans results in essentially the same improvements to inland river water quality.

A primary conclusion drawn from baseline studies conducted by the Institute of Water Research at Michigan State University was that ". . . even 100% elimination of municipal and industrial wastes from Southeastern Michigan, coupled with clean-up of Michigan's tributary streams, would not be adequate in significantly improving conditions in Lake Erie . . . for any major improvements of water quality to be realized in Lake Erie it is essential to reduce inputs from all watersheds bordering the Lake, not just Michigan's." The conclusions drawn were based on suggestions that "the single most outstanding treatment need for Lake Erie after disease threats are eradicated" was phosphorus removal. Assessment of abilities of the plans to improve water quality in Lake Erie were based on an assumption that similar plans would be implemented throughout the western basin and that proper land management and wastewater treatment would be employed to reduce phosphorus in tributary streams throughout the western basin.

Although the Interim Plan may have some effect on improving water quality in the Lake, algae related problems would not be affected and

improvement to the Lake may not be obvious. If any of the three Representative Plans were implemented, algae related problems in the eastern half of the Lake should be reduced. Improvement of the western half of the Lake would only be realized over a period of many years if at all.

The use of irrigation for treatment of wastewater as in Representative Plans Two and Three could result in increased ground water levels and an increase in stream flow in the vicinity of irrigation areas. Ground water contamination from irrigation areas should not be a problem. Ground water contaimination would be possible in the vicinity of areas used for disposal of stormwater sludges and incinerator ash from any one of the plans, from treatment and storage lagoons, and from land application of sludge associated with land irrigation treatment in Representative Plans Two and Three.

Aquatic Life and Waterfowl

The effect that any of the alternative plans would have on aquatic life habitats can be directly related to the degree of improvement in water quality. A primary problem to aquatic life in Lake Erie and inland streams is the maintenance of sufficient oxygen levels. Low oxygen levels result from both the oxygen demanding substances in waste discharges and from excessive plant growth resulting from an abundance of nutrients (phosphorus and nitrogen) in wastewater. In the alternatives, stream quality and thus aquatic habitats would be improved by increased levels of wastewater collection and treatment and by diversion of treated discharges to points further downstream. Storm runoff has been a serious problem in southeastern Michigan rivers and in the bays near the river mouths.

Many factors have led to the great change in fish populations in Lake Erie and inland streams; moreover, elimination of all urban waste discharges would not be sufficient for the system to recover to its previous

condition. Artificial stocking will continue to be necessary to maintain game fish populations. The evaluators concluded that "Changes in the fish population are probably much more dependent now on the management of fisheries in Lake Erie than on some reversal of eutrophication."

Improved water quality and aquatic life habitats would also have positive effects on waterfowl. Although the marsh lands bordering Lake Erie, Lower Detroit River, and Lake St. Clair have been reduced to a fraction of their former size and habitat deterioration from various forms of pollution has occurred, significant numbers of waterfowl still use the area. Improved wastewater management programs would be beneficial to waterfowl by controlling toxic substances such as oils, heavy metals, and biocides that may cause direct mortality, and by maintaining the plant and animal communities that serve as food.

Public Health

Restrictions placed on recreational use of Southeastern Michigan surface waters are primarily caused by contamination by pathogens (bacteria and virus) from partially treated wastewater discharges and combined storm and sanitary sewer overflows. Since all four plans place emphasis on eliminating sources of pathogen contamination, implementation of any of the plans would result in increased potential for recreational development of Southeastern Michigan surface waters. Conditions would be somewhat better if one of the three representative plans were implemented since disinfection measures would be much more efficient and more stormwater treatment would be employed.

There have been many potential public health hazards identified with treatment plant operations, wastewater lagoon treatment and land irrigation treatment. Some of those potential hazards include pathogen contamination of air in the vicinity of treatment plant aeration basins or

aerated lagoons, chlorine handling hazards, incineration of by-products, or disease transmission by waterfowl and wild game. Further study would be required into both engineering methods to avoid the problems and to determine the severity of the problems. The basic opinion of the evaluators, however, was that, until substantial data is available on land irrigation, wastewater treatment in plants would be the preferred method of treatment; thus, human consumption of crops grown on irrigated lands, as suggested in Representative Plan 3, should be discouraged. This would indicate that, with present knowledge, Representative Plan One would be preferred followed by Two and Three.

Energy and Natural Resources

All of the plans would employ incineration and related combustion techniques extensively. Designs call for use of advanced methods to insure complete combustion of exhaust gases and removal of essentially all particulate matter. Unless new techniques are developed, there are no practical means to remove oxides of nitrogen and sulfur from exhaust gases. At this point in time it would be difficult to assess the effect of the emissions on the atmosphere in Southeastern Michigan. The total quantity of combustion gas would be greatest for Representative Plan One, only slightly less for Representative Plans Two and Three, and much less for the Interim Water Quality Plan.

There is little difference in demands placed on energy (electrical and fuel), chemicals, or the atmosphere by the Representative Plans. The Interim Plan can be expected to have roughly half the demands for chemicals and energy estimated for the Representative Plans. The primary concern should be focused on energy requirements since the major resource consumed in manufacturing both lime and chlorine would be energy. Table 17 lists the electrical and fuel energy requirements, chemical requirements, and equivalent energy requirements identified for each plan.

Table 18

ENERGY AND CHEMICAL REQUIREMENTS

	Peak Electrical Power (Megawatts)	Average Electrical Power (Megawatts)	Fuel Oil or Natural Gas (10^9 BTU/Day)	Lime (Tons/Day)	Chlorine (Tons/Day)	Equivalent Electrical Energy (Megawatts)
Interim Water Quality Plan	NA	132	10	NA	38	136
Representative Plan One	2164	265	33	1550	426	315
Representative Plan Two	2205	290	33	1490	411	339
Representative Plan Three	2198	285	33	1490	411	334

Employment

Each of the plans could be implemented within the time frame dictated by the law, if an intensive program of construction was undertaken. This would result in excessive demands both for direct construction labor and labor which would be required for equipment fabrication and related fields. A question has been raised as to whether an area-wide demand for labor, materials and equipment could be met. Construction labor demands would be about equal for the Representative Plans and somewhat less for the Interim Plan.

Operating labor demands would not be excessive for any of the plans. Since operations at the plants are becoming more complex, the skill level of the wastewater treatment plant operators would have to be higher than in the past. The requirements could be met by instituting training programs far enough in advance of the need. The operating labor requirements for each plan are listed below:

Interim Water Quality Plan	1500 men
Representative Plan One	3249 men
Representative Plan Two	3197 men
Representative Plan Three	3163 men

Land and Water Use Changes

Of the four plans, the Interim Plan would cause the least change in existing and proposed land use. The primary changes would be due to location of stormwater storage facilities and location of the new Huron River treatment plant. The three Representative Plans share many common facilities and would for the most part have similar impacts on land use. The primary impacts would be a result of location of stormwater storage

facilities throughout the service area. Expansion of existing wastewater treatment plants in Detroit and Wyandotte would require displacement of land now in high density residential use.

The Representative Plans differ in the methods of handling wastewater in St. Clair and Lenawee Counties. In Plan One, 80 acres would be required in East China and 20 acres would be required in the Adrian area for wastewater-stormwater treatment plants. In Plans Two and Three there would be no plants in the East China or Adrian areas; however, agricultural land in both St. Clair and Lenawee Counties would be affected. For both plans 4,120 and 590 acres, respectively, would be required for treatment and storage lagoons in St. Clair and Lenawee Counties. That would probably displace land in agricultural use. An additional 1,059 and 450 acres respectively of agricultural land would be devoted to sludge disposal and forage crop production. In Plan Two 18,600 acres in St. Clair County and 3,900 acres in Lenawee County would be used for irrigation of wastewater. Although the land would be maintained in agricultural use, crops would be restricted to forage type and control of the land would rest with the managing agency. In Plan Three 53,600 acres in St. Clair County and 16,850 acres in Lenawee County would be irrigated; however, crop types would not be restricted and control would rest with the individual farmer.

Each of the plans offers opportunities for expanded recreation and open space development in the vicinity of new wastewater facilities. Improved water quality would also contribute to development of recreation. The degree of development of opportunities would have to be the choice of the implementing agency or the local governmental unit.

Opportunities for developing water reuse have been discussed in Chapter 3 of the Summary Report. The greatest opportunities would be presented in the Representative Plans, primarily in those plans which utilize irrigation.

Land Values

Changes in land values, as a result of plan implementation, would be due to improved water quality or proximity of wastewater facilities. Land values could be expected to increase along shorelines and in the vicinity of developed recreational areas. Some decrease in values could be expected due to odor problems or the general stigma associated with wastewater. No general comparison between plans would be feasible since these effects would be local in nature.

Area Economy and Institutions

A sound basis exists for regional wastewater management in Southeastern Michigan. The most severe problem to be encountered in implementing one of the plans would be the acquisition of land required for stormwater storage and wastewater treatment facilities. Resistance from communities forced to abandon existing treatment plants would also pose problems.

Another problem for local governmental units would be the loss of land from tax rolls. This could be a significant factor in selection of a method of treatment in St. Clair County since Plan One would require 80 acres, Plan Two 23,800 acres and Plan Three 5,200 acres.

The construction program associated with implementation of one of the plans would have a significant effect on the local economy through increased payrolls, increased demand for construction materials and machinery, and secondary economic effects. Costs to individual families for wastewater treatment would increase since the local share of the construction cost and operation and maintenance costs would be paid through user charges. Impacts would be greater for the Representative Plans than for the Interim Plan.

With the exception of the reuse potentials discussed in Chapter 3 of the Summary Report, there should be no direct effect of expanded wastewater treatment on existing economic enterprises.

Socio-Economics

Implementation of any plan of this magnitude would require displacement of individuals who occupy the affected land. Depending upon the individuals and how the displacement is handled, the overall impact could be positive or negative. No precise data was developed giving the number of families affected by each proposed facility so there are no numerical comparisons of the effects of implementing each alternative. Some degree of comparison can be made based on the amount of land required for each plan.

A positive social effect would result from expansion of open space and recreational development. The degree of development, as previously pointed out, would depend on local units of government.

System Costs

The costs estimated for the four final plans are presented in Table 18. The capital costs and operation and maintenance costs are based on cost indices for Detroit, January 1972. All annual costs are computed for a project life of 50 years and an annual interest rate of 5-1/2%.

It is obvious that there is a distinct cost difference between the Interim Plan and the three Representative Plans; however, there is no significant difference in total cost between the Representative Plans. When comparing the Representative Plans on a cost basis, the cost differential becomes more obvious when examined only for the service areas in St. Clair County and Lenawee County.

Table 19

COST COMPARISON OF REPRESENTATIVE PLANS

	Construction Cost $Million	Annual O&M Cost $Million	*Annual Cost to Southeastern Michigan $Million	Total Annual Cost $Million
Interim Water Quality Plan	2,190	23.5	56.0	153.0
Representative Plan One	4,184	123.5	185.5	370.6
Representative Plan Two	4,257	124.2	187.1	375.6
Representative Plan Three	4,498	132.7	199.1	398.3

*Based on 25% local financing of initial capital cost and total local funding of operation and maintenance costs.

PUBLIC INVOLVEMENT

The fourth, and last, series of public meetings was held during December 1973 in Ann Arbor, Detroit, Port Huron, and Monroe. These meetings introduced the public to Representative Plans One, Two, and Three, and to the Interim Water Quality Plan. These plans will be presented to the State as long-range wastewater management plans for southeastern Michigan.

This series of meetings was attended by local people concerned with local problems. For example, at the Ann Arbor meeting, many comments were made on the Huron River interceptor. In general, people in Ann Arbor are opposed to the construction of the Huron River interceptor which is part of the Interim Water Quality Plan. The questions covered the following types of subject matter:

Lenawee County - number of acres needed and cost of facilities.
Elimination of Huron River interceptor.
Use of crops grown on irrigated land.
No analysis of Plan Two to show it is most cost effective.
Lack of costing figures and implementing plans.
Incentives for farmer to accept irrigation water.
Type of locations planned for the reservoirs.
Necessity of underdrains in land treatment.
Types of stormwater to be collected.
Use of crops harvested before maturity.
Necessity of energy comparisons.
Spacing of access shafts to deep tunnels.
Costs of drying and burning sludge.
Types of crops to be grown.

It was announced at each meeting that copies of the draft reports would be placed in seven college and university libraries and 14 county and

city public libraries. Comments on any part of the study were to be submitted to the Detroit District no later than 1 February 1974 for inclusion in the Final Study Report.

INSTITUTIONAL ARRANGEMENTS AND IMPLEMENTATION

As stated in the Introduction, the purpose of an investigation of institutional management schemes is to analyze the capabilities of existing and proposed wastewater management organizations relative to selected technical wastewater management systems. A number of institutional management schemes, each possessing sufficient authority to plan, construct, operate and maintain the systems developed during the study, have been proposed for the Southeastern Michigan area. These institutions can be classified in six categories which cover management on various levels of political interaction. These six classifications involve wastewater management by:

- State Agency or Utility
- Regional Agency
- County Agency
- Municipal or Local Agency
- Water and Sewage Authority
- Management thru Intergovernmental service agreements (referred to as intercounty agreements)

1. STATE AGENCY OR UTILITY - This type of institutional mechanism involves an executive or departmental agency to the State actually undertaking the direct performance of an urban function. In practice, aspects of functions may be transferred to a State agency rather than the total function. For example, if a State agency provides water for a metropolitan region, it (the State agency) is usually responsible for the actual source of the water supply plus the major trunk lines to convey the water from the source throughout the metropolitan region. Local distribution systems, however, are often left to the localities themselves.

2. REGIONAL AGENCY - The multiple purpose District/Authority represents an independent unit of government established through State law to perform a number of services in all or most portions of a metropolitan area. The multiple purpose District/Authority may be established initially with only 1 or 2 actual functions; however, the enabling legislation vests in the area affected the capability for the District/Authority to take on additional functions as the need arises.

3. COUNTY AGENCY - Under this type of an arrangement, the county government increases its provision of services which are normally of a municipal nature to include the entire county. This action requires the transfer of functions from municipalities and any special districts together with the gradual expansion of activities in unincorporated urban areas. It may be necessary for the State to grant a number of functional powers to counties in metropolitan areas. Act 342, Public Acts of 1939 allows a county to provide wastewater management services within its boundary as well as in consenting neighboring governmental units. (Unless otherwise identified, Public Acts refer to current wastewater management legislation in the State of Michigan).

Certain legislative acts stipulate that the county agency is capable of providing services within a boundary specifically limited to a local area. Act 40, Public Acts of 1956, Chapter 20, stipulates that a designated "agency" in this case a drain commission, may provide for collection and transmission of wastewater within a county. Act 185, Public Acts of 1957, established a Department of Public Works to provide for WWM services within a county.

4. MUNICIPAL OR LOCAL AUTHORITY - The limited purpose metropolitan special district or authority is an independent unit of government organized to perform one or more urban functions throughout all or a part of a metropolitan area. In most cases, the activity is service as opposed to regulatory,

for example water supply or sewage disposal. The financing of such an independent unit of government is primarily through service changes, sales, rents, tolls. Revenue bonds constitute the primary source of capital funds for project construction.

5. WATER AND SEWAGE AUTHORITY - Act 233, Public Acts of 1955 allows for the establishment, by consenting governmental units, of an authority to provide both wastewater and water supply services. The authority can finance facility construction by the provision of contract bonding and, in this aspect, the provisions are similar to those mentioned in Act 342, Public Acts of 1939. Full faith and credit for these bonds is established by the financial stability of the contracting governmental units.

6. MANAGEMENT THRU INTERGOVERNMENTAL SERVICE AGREEMENTS - Under such a device, one unit of government conducts an activity jointly or cooperatively with one or more other units of governments. Typically, contracts may be drawn up whereby one public corporation or unit of government agrees to provide specified services to other units of government according to terms specified in the contracts. Therefore, the extraterritorial power represents the exercise of authority by one unit of government beyond its traditional political boundary. For example, the Detroit Metropolitan Water Department and the Wayne County Road Commission provide sewage service to communities under Intergovernmental Service Agreements.

The examination of these six institutional management schemes took place in two evaluations. The first was to determine the potential of five existing representative wastewater institutions created by current legislation, to implement proposed regional wastewater management plans. The second evaluation examined a range of institutional management schemes which involved the combination of existing and proposed management systems.

In the initial evaluation the following existing institutions would be most capable of managing the proposed alternatives:

1) The Michigan Water Resources Commission (WRC) Department of Natural Resources (DNR) was selected for examination as a State agency because of its numerous wastewater management responsibilities. In 1972, the WRC undertook the drainage responsibilities of the Department of Agriculture and the wastewater engineering responsibilities of the Engineering Division, Department of Public Health.

2) For a representative regional wastewater management institution the Detroit Metropolitan Water Department (DMWD) was selected. The DMWD provides wastewater treatment for 79 communities, and supplies water for 92 communities. Its legislation allows it to provide service by contracts, akin to the nomenclature "management thru intergovernmental service agreements."

3) Act 185, Public Acts of 1957, is the legislation establishing a county department of public works, while Act 40, Public Acts of 1956 establishes a county drain commission. An evaluation of the utilization of wastewater management legislation in the Southeastern Michigan Wastewater Management Study Area depicts that these two acts are most frequently employed to undertake comprehensive wastewater management responsibilities.[1] Thus, these two acts were examined.

4) Legislation which allows a governmental agency to provide comprehensive wastewater management in the State of Michigan on a county basis, in addition to expanding its boundaries, is Act 342, Public Acts of 1939 - The County Public Improvement Act. An example of an agency using this legislation for wastewater responsibilities is the Wayne County Road Commission.

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[1] Page 114, Table 12, Management On A Local Jurisdictional Level, Institutional Arrangements Appendix.

These then were the categories of institutions which were selected as being representative wastewater management institutions for the Study Area for the initial evaluation.

An assessment was undertaken to determine the ability of these institutions, utilizing current legislation, to provide the comprehensive wastewater management reponsibilities inherent in the 7 selected alternatives.

The following is a synopsis of the preceding initial evaluation denoting the ability of representative institutions to implement the Corps alternatives.

1. State Institutions (Water Resources Commission - WRC) - The State (WRC) cannot presently implement any of the alternatives without major institutional additions.

2. Regional Institutions (Detroit Metropolitan Water Department - DMWD) - Except where the Detroit-Jefferson Avenue Plant is phased out, resulting in financial loss considerations, DMWD in its present form could implement the alternatives with little difficulty.

3. Local Institutions (Act 342, Public Acts of 1939) - Except where the Wyandotte Plant is phased out, (Combination 1) resulting in financial loss considerations, Act 342, Public Acts of 1939, affords the designated management agency the ability to implement any of the alternatives.

4. Local Institutions (Act 185, Public Acts of 1957 and Act 40, Public Acts of 1956) - Act 185, Public Acts of 1957, and 40, Public Acts of 1956, may be utilized to implement any alternative with certain limitations; due mainly to jurisdictional limitations and the extent of wastewater management authority.

A subsequent analysis of potential management institutions was undertaken to assess the feasibility of a number of potential organizations to implement the technical wastewater management alternatives.

A summary of the findings depicts the following:

- The alternative utilizing only the land irrigation treatment concept is best implemented by a State Utility, a Regional Government, or a Wastewater Authority;

- Implementation of a total Independent-Physical Chemical alternative, designating the total utilization of physical-chemical plants for treating municipal and industrial wastewater, in addition to combined sewer overflows and storm runoff could be accomplished by a State Utility, a Regional Government, a Water and Sewage Authority and a County Government;

- Five feasible management institutions could implement an Advanced Wastewater Treatment alternative. These are a State Utility, a Regional Government, a Water and Sewage Authority, a County Government, and management through Intergovernmental Service Agreements.

The two evaluations were analyzed in light of the final 3 representative wastewater management plans. The analysis and examination of these representative institutional classifications, with respect to the revised selected plans (and the potentially related degrees of political interaction, extension of political boundaries, etc.) has shown that Representative Plans One, Two, and Three may be effectively undertaken by the following management schemes in the order of least implementable difficulty to major institutional problems:[1]

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[1] Refer to pages 157, 158 of the Institutional Arrangements Appendix for further discussion.

1. Regional Agency
2. Water and Sewage Authority
3. Intercounty Agreements
4. State Agency
5. County Agency
6. Local or Municipal Agency

Implementation of any of these or other management institutions in the study area will be determined according to the current state of affairs in water quality operations in the Southeastern Michigan region and by existing and proposed wastewater management legislation.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 stipulates the requirements and responsibility of the Governor of Michigan, after consultation with appropriate governmental authorities in their field, to designate representative organizations capable of developing effective area-wide treatment management plans for wastewater management districts. In addition, the Governor, in consultation with this selected planning agency, ". . . shall designate one or more waste treatment management agencies, which may be an existing or newly created local, regional, or state agency or political subdivision . . .".

PHASING AND IMPLEMENTATION

Although the Interim Water Quality Plan was designed to achieve the 1983 objectives and the Representative Plans were designed to approach the 1985 objectives of Public Law 92-500, each plan could be implemented so that interim objectives of the law could be met. However, it must be recognized that the implementation of the Interim Water Quality Plan would preclude the implementation of any of the Representative Plans by the specified date of 1985. If the Interim Plan was selected for implementation, any one of the Representative Plans could be achieved and many of the facilitites from the Interim Plan could be used but additional time (up to 15 years) would be required for implementation. It is most probable however that revisions would be made or a new plan would be designed if the Interim Plan was selected and a higher degree of treatment was to be met at a later date. Since planning is a continuous process, this is a logical assumption.

Construction sequencing will be an important factor in achieving the interim and final objectives on schedule. The phasing of construction and facility start-up will control the flow of money in the project. The structuring of the construction and start-up or phasing and implementation program for each alternative plan will facilitate the examination of comparative economic costs.

Priorities and Policies

Sequencing of construction and start-up is controlled by: interim water quality objectives, funding schedules and construction practicality. The following is a list of some of the more important priorities and policies:

a. Construction program to commence on 1 January 1975.

b. Construction of the Interim Plan to be complete by 1 July 1983 and Representative Plans by 1 January 1985.

c. 1977 and 1983 objectives of the law to be met.

d. Premature investment of capital to be avoided by construction sequencing.

e. Pilot plant study to be employed prior to final facility design.

f. Combined sewer service areas to be given priority in construction of the stormwater management system.

g. Stormwater storage facilities to have priority over stormwater treatment.

h. Soil erosion to be controlled in rural and outer suburban areas by use of good land management practices.

Procedure

The phasing of the various plans applies to only those new treatment systems or components that would be added to the base (1975) system. Construction costs include the capital investments needed to build facilities required to achieve the relevant water quality objectives within the legal schedule. As newly constructed facilities are placed in operation, their appropriate O and M and replacement costs commence. O and M costs for those components in place by 1975 are not included or considered prior to this date. When an existing component is incorporated into a proposed system and additional processes are added after 1975, to achieve the appropriate water quality objectives, the entire O and M costs (for both new and old processes) are included in the phasing costs.

Two constraints are imposed on the phasing and implementation programs in order to facilitate the comparison of impacts caused by the alternatives. First, the construction schedule and the start-up schedule for a given system are identical for all alternatives and are specified by total construction capital expended versus time and by percentage of 1990 capacity placed in operation versus time, respectively. Second, the percentage of total construction capital expended versus time is held to a uniform rate. The above two constraints are compatible with logical implementation programs for each of the alternatives and provide, at the same time, for an effective and efficient comparison of impacts of the alternatives.

A third constraint, or freedom from constraint in this case, is that construction capital funds are available appropriate to the phasing selected.

The programs for the Representative Plans, Nos. one, two and three are in Tables 19 to 30 inclusive. In explanation of these tables:

Column 1 is the capital cost, that is the cost of constructing the separate members that are listed and comprise the regional system.

Column 2 is the required expenditure each year for ten years to build the entire system in the interval 1975 to 1985.

Column 3 shows the present worth of the sums required for the disbursements each year in Column 2; that is these amounts posted at the beginning of 1975 would generate at the specified percent the sums necessary for each 10 year of construction payment.

Column 4 gives the payments that must be made each year for 50 years to amortize the construction capital costs which in turn are paid from the sums generated by the present worth amounts shown in Column 2.

The totals for the separate members are shown at the bottom; the total expenditure over 50 years is also shown at the bottom of Column 4.

TABLE 20

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,389.08	138.91	1,072.66	58.75
Wastewater Interceptors and Transmission Lines	214.61	21.46	165.71	9.07
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,978.06	108.35
Landfill Sites				
St. Clair County	6.47	0.647	4.99	0.27
Lenawee County	11.7	1.17	[illegible]	[illegible]
TOTALS	4183.46	418.34	[illegible]	176.93
Total of 50 yr payments from 1975 to 2025				[illegible]

TABLE 21

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,320.05	132.005	1019.34	55.83
Land Treatment Systems				
St. Clair County	62.81	6.281	48.50	[illegible]
Lenawee County	24.52	2.452	18.93	1.03
Wastewater Interceptors and Transmission Lines	236.44	23.644	182.57	10.00
Stormwater Collection Storage and Transmission	2,561.60	256.16	1978.06	108.35
Landfill Sites				
St. Clair County	6.15	0.615	4.74	0.25
Lenawee County	11.28	1.128	8.71	0.47
TOTALS	4,222.8	422.285	3,260.85	178.58
Total of 50 yr payments from 1975 to 2025				8,929.0

TABLE 22

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,320.05	132.005	1,019.34	55.83
Land Treatment Systems				
St. Clair County	194.5	19.45	150.19	8.22
Lenawee County	63.6	6.36	49.11	2.69
Wastewater Interceptors and Transmission Lines	236.44	23.644	182.57	9.99
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,978.06	108.35
Landfill Sites				
St. Clair County	6.15	0.615	4.74	0.25
Lenawee County	11.28	1.128	8.71	0.47
TOTALS	4,393.62	439.36	3,392.72	185.40
Total of 50 yr payments from 1975 to 2025				[illegible]

TABLE 23

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditures 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,389.08	138.91	1,047.10	61.84
Wastewater Interceptors and Transmission Lines	214.61	21.46	161.77	9.55
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,930.93	114.04
Landfill Sites				
St. Clair County	6.47	0.647	4.87	0.28
Lenawee County	11.7	1.17	8.81	0.52
TOTALS	4,183.46	418.34	3,153.48	186.23
Total of 50 yr payments from 1975 to 2025				9,311.50

TABLE 24

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,320.05	132.005	995.05	58.769
Land Treatment Systems				
St. Clair County	62.81	6.281	47.35	2.796
Lenawee County	24.52	2.452	18.48	1.09
Wastewater Interceptors and Transmission Lines	236.44	23.644	178.23	10.526
Stormwater Collection Storage and Transmission	2,561.60	256.16	1930.93	114.04
Landfill Sites				
St. Clair County	6.15	0.615	4.64	0.274
Lenawee County	11.28	1.128	8.50	0.502
TOTALS	4,222.8	422.28	3,183.18	187.997
Total of 50 yr payments from 1975 to 2025				9,399.85

TABLE 25

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditures 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,320.05	132.005	995.05	58.769
Land Treatment Systems				
St. Clair County	194.5	19.45	146.61	8.659
Lenawee County	63.6	6.36	47.94	2.831
Wastewater Interceptors and Transmission Lines	236.44	23.644	178.23	10.526
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,930.93	114.04
Landfill Sites				
St. Clair County	6.15	0.615	4.64	0.274
Lenawee County	11.28	1.128	8.50	0.502
TOTALS	4,393.62	439.36	3311.9	195.601
Total of 50 yr payments from 1975 to 2025				9,780.05

TABLE 26

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 Yrs @ 7% Col. 3x0.072460
Wastewater Treatment Plants	1,389.08	138.91	975.70	70.69
Wastewater Interceptors and Transmission Lines	214.61	21.46	150.73	10.92
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.47	0.647	4.54	0.32
Lenawee County	11.7	1.17	8.21	0.59
TOTALS	4,183.46	418.34	2,938.44	212.89
Total of 50 yr payments from 1975 to 2025				10,644.5

TABLE 27

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 Yrs @ 7% Col. 3x0.072460
Wastewater Treatment Plants	1,320.05	132.005	927.20	67.18
Land Treatment Systems				
St. Clair County	62.81	6.281	44.11	3.19
Lenawee County	24.52	2.452	17.22	1.24
Wastewater Interceptors and Transmission Lines	236.44	23.644	166.07	12.03
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.15	0.615	4.31	0.31
Lenawee County	11.28	1.128	7.92	0.51
TOTALS	4,222.8	422.285	2966.09	214.89
Total of 50 yr. payments from 1975 to 2025				10,744.50

TABLE 28

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 yrs @ 7% Col. 3x0.07246
Wastewater Treatment Plants	1,320.05	132.005	927.20	67.18
Land Treatment Systems				
St. Clair County	144.5	19.45	136.61	9.89
Lenawee County	63.6	6.36	44.67	3.23
Wastewater Interceptors and Transmission Lines	236.44	23.644	166.07	12.03
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.15	0.615	4.31	0.31
Lenawee County	11.28	1.128	7.92	0.57
TOTALS	4,393.62	439.36	3,086.04	223.58
Total of 50 yr. payments - 1975 to 2025				11,179.0

TABLE 29

REPRESENTATIVE PLAN ONE - CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE : 10%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 10% - 1975-1985 Col. 2x6.145	Average Annual Cost 50 Yrs 10% Col 3xx.100859
Wastewater Treatment Plants	1389.08	138.91	853.60	86.09
Wastewater Interceptors and Transmission Lines	214.61	21.46	131.87	13.30
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.47	0.647	3.97	0.40
Lenawee County	11.7	1.17	7.19	0.72
TOTALS	4183.46	418.35	2570.72	259.27
Total of 50 yr payments - 1975 to 2025				12,963.50

TABLE 30

REPRESENTATIVE PLAN TWO CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 10%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 10% 1975-1985 Col. 2x6.145	Average Annual Cost 50 yrs @ 10% Col.3x0.100859
Wastewater Treatment Plants	1,320.05	132.005	811.17	81.81
Land Treatment Systems				
St. Clair County	62.81	6.281	38.59	3.89
Lenawee County	24.52	2.452	15.06	1.51
Wastewater Interceptors and Transmission Lines	236.44	23.644	145.29	14.65
Stromwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.15	0.615	3.77	0.38
Lenawee County	11.28	1.128	6.93	0.69
TOTALS	4,222.8	422.285	2,594.91	261.69
Total of 50 yr payments - 1975 to 2025				13,084.5

TABLE 31

REPRESENTATIVE PLAN THREE CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 10%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 10% - 1975-1985 Col. 2x6.145	Average Annual Cost 50 yrs @ 10% Col. 3x0.100859
Wastewater Treatment Plants	1,320.05	132.005	811.17	81.81
Land Treatment Systems				
St. Clair County	194.5	19.45	119.52	12.05
Lenawee County	63.6	6.36	39.08	3.94
Wastewater Interceptors and and Transmission Lines	236.44	23.644	145.29	14.65
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.15	0.615	3.77	0.38
Lenawee County	11.28	1.128	6.93	0.69
TOTALS	4,393.62	439.36	2,699.86	272.28
Total of 50 yr payments - 1975 to 2025				13,614.0